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WORLD PETROLEUM

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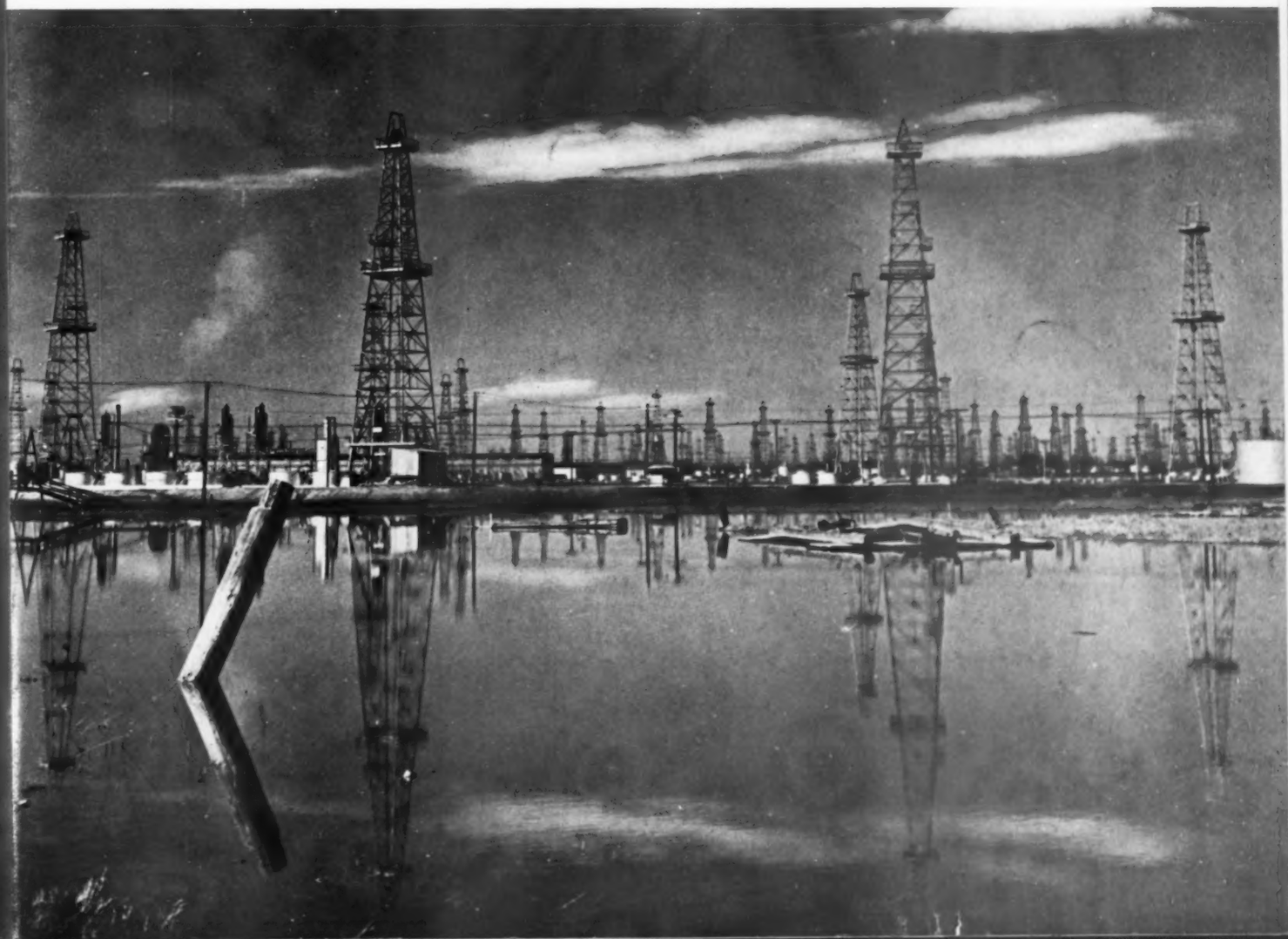

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WORLD PETROLEUM

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Looking down on oil derricks in a deep valley among the foothills of the Carpathian Mountains.

British Combine Photos, Ltd.

EDITORIAL

PRICE FACTOR IN PRORATION

ACTION of state authorities in oil producing states in ordering a complete shutdown of wells following the recent cut in posted crude prices brings forward a question that for the most part has been carefully avoided in the issuance of proration orders and in discussions of regulatory acts. That is the bearing of price in relation to the regulation of petroleum output.

Earlier state legislation based its authorization of control over petroleum production wholly on the avoidance of physical waste. It was intended to prevent the unnecessary dissipation of gas, the lowering of bottom hole pressures or other avoidable practices that would lead to a failure to recover the full amount of oil otherwise obtainable. Theoretically the size of overground stocks, the activity or sluggishness of the market and the prevalence of high or low prices had no bearing upon decisions.

Actually, however, state regulatory bodies have not been able to close their eyes entirely to market conditions and undoubtedly they have been influenced to some extent in raising or lowering allowables by consideration of the probable effect on prices. In attempting to utilize control over production for the primary purpose of influencing prices, however, state authorities are embarking upon a course that may have serious consequences to the industry and to themselves should it become frequent practice.

In determining the proper per acre distribution of wells in a field or deciding what rate of production will best preserve bottom pressures one is dealing with physical problems for which competent engineers can figure out an accurate answer. But in trying to decide what is a reasonable price for a barrel of oil one enters the realm of opinion where there are likely to be as many different views as there are men to express them. Nevertheless there is such a thing as economic waste. It occurs when production persistently exceeds market demand. Both physical and economic wastes have a bearing upon price that cannot be wholly overlooked.

Market Demand

IN RECENT state laws governing regulation this problem has been met directly and has been dealt with clearly. For example, the California oil and gas control act, which became law only in July last, includes in its legal definition of the various kinds of waste that are to be prevented "the production of crude petroleum oil in excess of the reasonable market demand."

Reasonable market demand is something that can be forecast from month to month with some approach to precision if not with mathematical accuracy. Such advance estimates for the country as a whole are issued regularly by the U. S. Bureau of Mines and over a long period they have been found to match closely with actual demand as it subsequently made itself known. If supplies do not exceed a reasonable market demand it is to be presumed that they will command a reasonable price. If the administrators of regulatory laws in states having such clearly specific provisions see output running ahead of current use, stocks accumulating and prices wavering they need have no question of their authority to put the brakes on production.

In promulgating the recent general shutdown of wells in several states and the partial restriction on production announced in others, the officials issuing the orders undoubtedly acted in accordance with what they felt to be the predominant sentiment of the people of their states. That they were correct in their interpretation was shown by the practical unanimity with which the orders were obeyed. This united support was due undoubtedly to the fact that the case was regarded as one of emergency. If it is so treated and not allowed to become a precedent for future action no harm need result. Successful regulation may well take account of the relationship between supply and demand but if price were to become the determining factor in its application it would be entering upon untried and highly dangerous ground.

Business vs. Politics

IF THE Mexican oil controversy involved only business men, it is a safe assumption that a mutually satisfactory solution could be worked out within a week. The fact that the men were of different nationalities would not affect the outcome. Because one government is directly involved and others have been drawn in, any sort of reasonable settlement appears to be decidedly remote if not entirely unattainable.

The reason for this difference in methods and conquences, or at least one reason, is that business men are interested solely in results and in finding a workable method of attaining them. To governments and the representatives of governments the all important thing is not results but appearances. Face saving is not merely an oriental characteristic—it is the universal aim of official procedure everywhere. National pride must be respected. The national honor can be invoked to uphold anything from the face slapping of a tourist to the outright seizure of a whole country or the despoilation of a whole class of individuals. In politics and diplomacy things are not what they seem. They assume strange and distorted shapes as though viewed in a magic looking glass.

The Mexican oil imbroglio is a case in point. Eighteen months ago President Cardenas seized the extensive oil properties owned by some thousands of British, Netherland and United States nationals, expelled the operators and announced that henceforth the industry was to be run by Mexico for the Mexicans. At that time Mexican production was at the rate of roundly 47,000,000 bbl. yearly. Exports of oil held a leading place in the country's overseas trade and paid for a large percentage of its imports. The oil industry provided approximately one-sixth of the nation's tax revenues. The oil companies disbursed many millions in wages, paying their workers three to four times the rate prevailing in other industries, and invested other millions yearly in the expansion of field operations, adding to transport equipment and improving refining facilities.

Results of Oil Seizure

FOLLOWING confiscation production fell off 20 percent during the remainder of 1938 with a further decline in the first half of 1939. Being operated by the government, the industry ceased to contribute taxes. Exploration, drilling and normal additions to plant have been neglected with the result that its efficiency continuously decreases. The pay of workers has suffered, their special privileges have been curtailed and drastic steps have been necessary to curb mass expressions of disaffection.

From the national viewpoint perhaps the most serious loss that Mexico has sustained from confiscation has been in its international trade. Shut off from the marketing outlets formerly provided by the oil companies, Mexico has had to offer its oil below world prices and to barter it for such commodities as it could obtain in exchange, chiefly from Germany and Italy. As a consequence its financial position has gone from bad to worse and its dependence upon the economy of the Axis countries contains possibilities of future difficulty and embarrassment.

Practical Way Out

UNDER these conditions, with both parties suffering losses that grow steadily higher and higher, the businesslike course would be for the Mexican authorities to say to the oil companies: "We are determined that Mexico's petroleum resources shall belong to the nation but we recognize that as specialists in this field you can handle the production and distribution of petroleum and its products to our advantage and your own. We are willing to reinstate you as managers for a fixed term of years, to guarantee freedom from undue governmental interference and unfair labor demands on condition that you pay over to the government a specified proportion of your receipts from the export of oil and at the end of the stated period turn over to us the properties with all improvements that have been made."

Such a proposal might be a bitter pill for the oil companies for it would involve surrender of title to properties legitimately acquired but it would give them an opportunity to obtain over a period of years some return upon the capital invested in the business if not to recover the face of the investment itself. Since their financial reward would depend wholly upon the efficiency of their management they would have every inducement to carry forward the development of the industry with utmost efficiency.

For its part the Mexican government would receive a vastly increased and greatly needed revenue from its petroleum industry and would measurably lessen its internal financial difficulties. It would accomplish its declared objective of establishing its ownership of the country's natural resources without sacrificing its revenue from their exploitation and without the unpleasant onus of disregarding international comity.

Apparently the only barrier to such a commonsense solution is the political dictum that a government or the head of a government must never admit to error in any step that he has taken. It would be a refreshing experience if one government would address itself to what is essentially a business problem with the realistic attitude that prevails in ordinary commercial transactions. That, the Mexican government apparently has the opportunity to do.

NEW GUINEA
Oil Search to be Intensified

N. N. G. P. M. in Netherlands Territory and Islands Exploration and Papuan Apinaipi in British Area Enter Second Stage of Their Exploration Programs as They Prepare to Sink Deep Tests On Pacific Island.

INTEREST in New Guinea's oil possibilities grows now that the companies operating in that part of the world virtually have completed their initial exploration by aerial surveys and scout bores and prepare to sink deeper wildcats on the basis of present knowledge.

N. N. G. P. M.

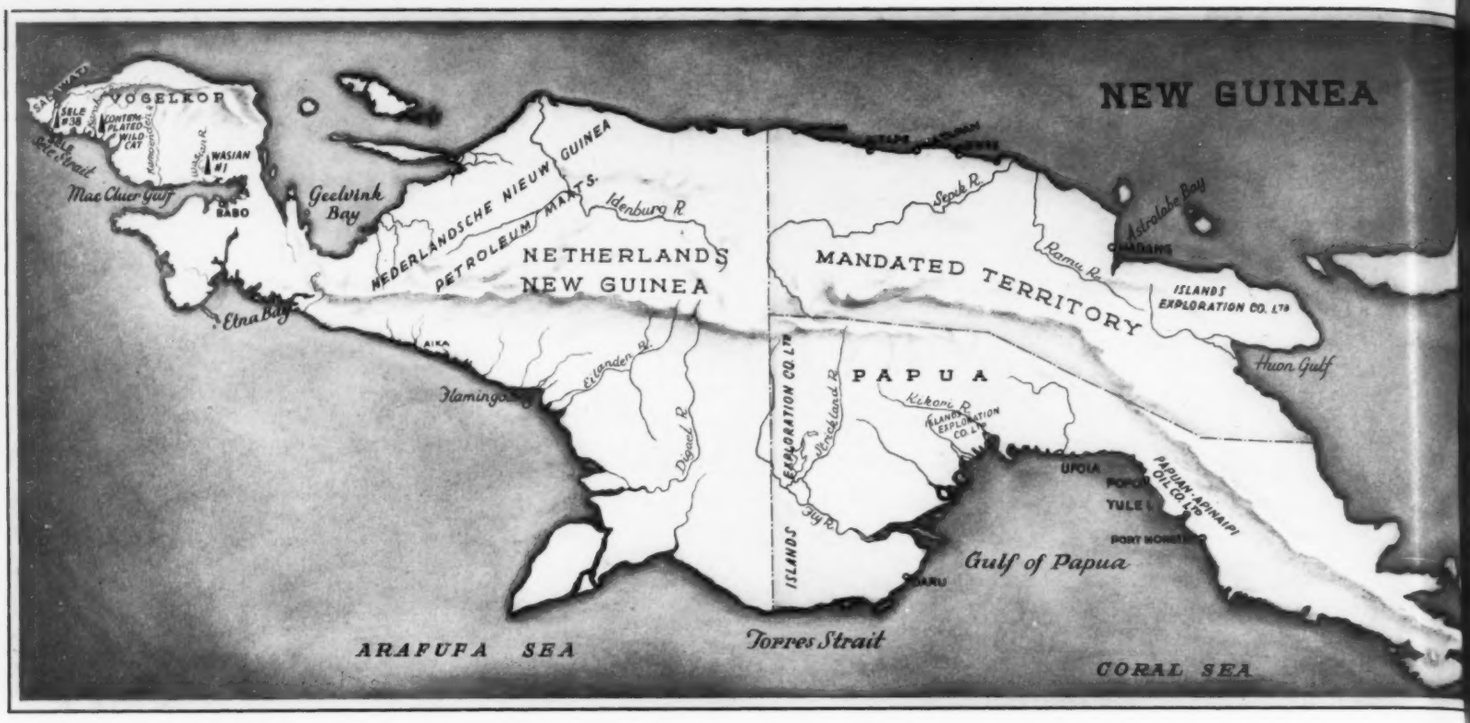
Greatest progress seems to have been made on the concessionary areas of Nederlandsche Nieuw-Guinee Petroleum Maatschappij, a joint-subsidiary of Royal Dutch-Shell, Standard Vacuum and California Standard in the relative proportions of 40, 40, and 20 percent, respectively, and N. N. G. P. M. has concluded its exploration and exploitation contracts with the government in accordance with the Netherlands Indian Mining Law.

Preparatory work had been started in 1935 and, after initial aerial exploration, about 80 shallow structural wells were sunk for geological reconnaissance. These wells have been drilling during the past few years on the island of Salawati, and others at Sele, Karabra and Metamani—all in the South Vogelkop region. Similar wells have also been sunk in the neighborhood of Babo and south of Etna Bay. The depth of the geological holes varied between 150 ft. and 2,100 ft.

Another structural well is at present being drilled near the upper course of the Kamoendan river, with the expectation of reaching a final depth of about 1,800 ft., while some similar wells shortly will be spudded-in near the Klamono river.

Following the detailed survey work carried out in a few places, deep tests have been started in the South Vogelkop region. Wasian No.1 well is about 55 mi. upstream in the upper course of the Temboeni river, Wasian basin, and is drilling ahead. A second well, Sele No. 38, has been spudded at a point 10 miles from Sele Strait, the most westerly part of the South Vogelkop concession. Within a short time preparations will be made for a third

Marine terminal facilities for the Babo camp are comparatively elaborate for such an undeveloped region, and the N.N.G.P.M. has a fleet of five motor cargo ships as well as some 92 smaller vessels.



Map of New Guinea showing the areas in which Papuan Apinaipi, Islands Exploration, and N.N.G.P.M. are operating, and the site of present deep drilling activities.

major test, of medium depth, at most 4,500 ft., near the Karabra river.

Meanwhile, geological and geophysical survey in other areas is being energetically pursued to ensure that sufficient data will be available in time to transfer the outfits to new structures and that the knowledge of areas only roughly surveyed will be supplemented by further details.

BABO CAMP

With drilling and geological work and geophysical surveys extending over a vast area, the locations being at great distances from each other and difficult of access, it is only natural that a centralized organization of personnel and means of transport are required. The main stores, office, hospital, repair shops and slipway are at Babo, where some 150 European employees and 800 natives are housed and catered for. Recreation facilities have been provided, including a football field, tennis and golf courses, and a movie house.

Most of the personnel employed up country come to Babo at regular intervals to work out their reports and seek some distraction, during which time they are also medically examined to ensure perfect health. At present there are two European doctors and a male nurse, while a female nurse shortly will be added to the medical staff. With the exception of a few details, no further extensions of Babo camp are contemplated.

Transportation facilities at Babo are well-organized, and the N. N. G. P. M. marine fleet consists of five freight-carrying motorships, eight proas (a native sailing vessel) for transport of materials, about 50 smaller proas most of which are equipped with outboard motors, 25 power launches, five houseboats and four barges. Overland transport is provided by six tractors, eight trucks, three narrow-gauge locomotives and a number of flatcars.

The company had originally acquired a Sikorsky amphibian for conducting its survey work, but this is being replaced by two new Grumman flying boats. The latter planes are especially adapted to the territory due to their amphibious design and their compact size which is so necessary for operation in what is mostly virgin jungle.

In the light of present exploration, the settlement at Babo is only a temporary one, and not until deep wells prove the existence of oil in commercial quantities can the establishment of a more permanent station be decided upon.

Up to the beginning of this year, the company had invested about 15,000,000 guilders ($8,000,000) in Netherland New Guinea, and as exploration now stands it can hardly be expected that oilfields of any importance will develop in New Guinea within the next few years.

Pipe racks at the material yard at N.N.G.P.M.'s Babo camp bear mute witness to the activity in that area.

PAPUA

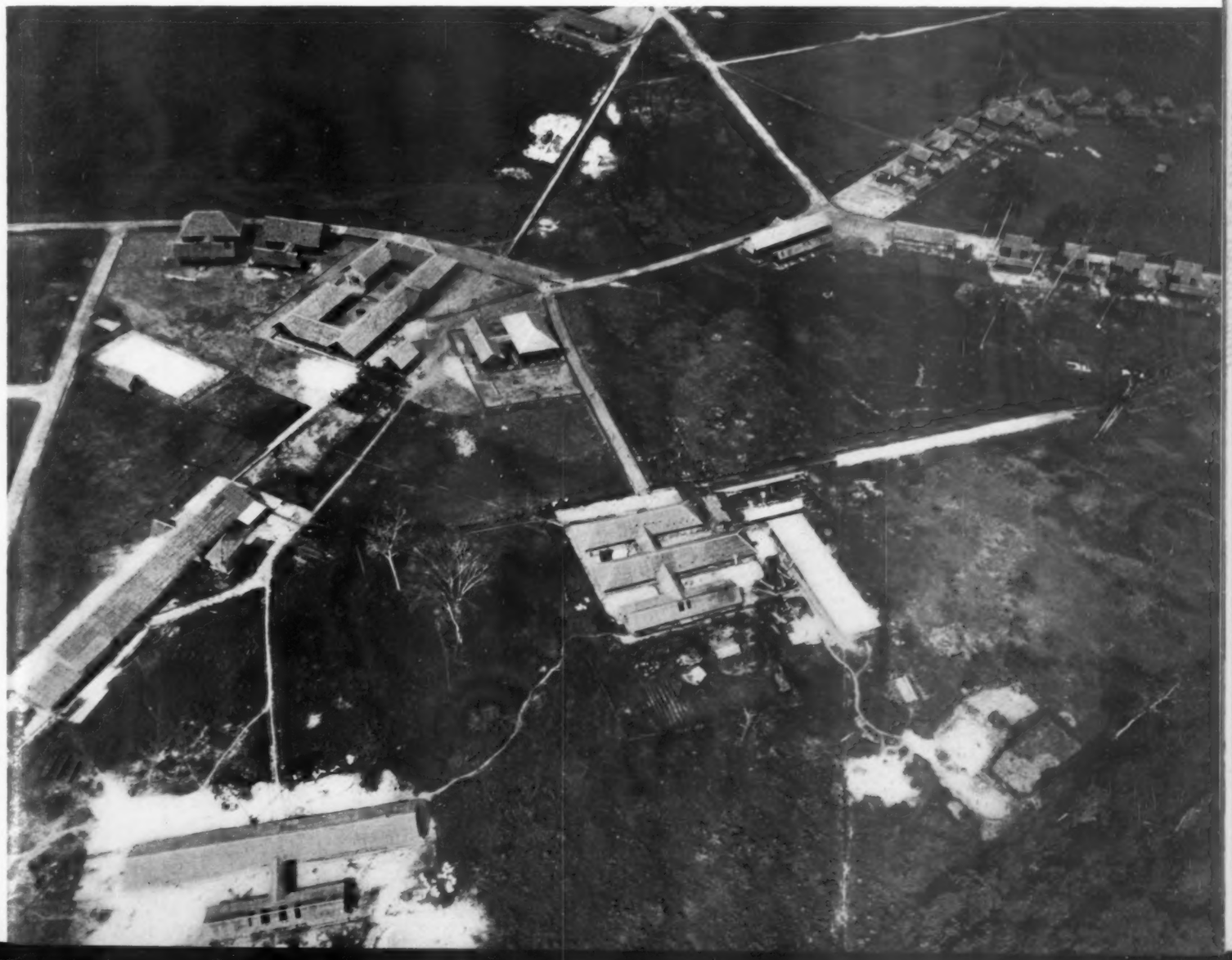
Progress has also been made in the British half of the island of New Guinea, and Islands Exploration Company, Ltd. (Standard-Vacuum interests) recently shipped a rotary rig from the United States to Papua with the intention of drilling a deep test somewhat west of Port Moresby. This drilling equipment, incidentally, has been specially adapted to the use of the fluid coupling to be described in WORLD PETROLEUM next month.

Papuan Apinaipi Petroleum Company, Ltd., has now completely photographed its concession from the air and three scout holes have been sunk in selected positions within the Oiapu structure to 1,124 ft., 523 ft. and 892 ft., respectively; in every case the information sought was obtained before com-

pletion. A fourth scout well is being drilled and the location of the first deep test has been fixed subject to the results from this well. It is expected that the company will start major drilling operation before the end of the year.

Detailed work and scout drilling has justified the transfer of the company's main operations from Apinaipi to Oiapu, and confirmed surface studies made the previous year. Despite the lack of surface indications of oil within the Oiapu structure, the underlying mudstone has been proven petroliferous throughout the area. The traces of extremely light oil encountered persistently during scout drilling strongly suggests migration and selective filtration through restricted channels before the beds attained their present degree of consolidation, and indicates the possibility that the shows were derived from a deep reservoir containing petroleum of much heavier gravity. All these holes gave evidence of shore-line conditions and existence of sea currents, during period of deposition, from southeast to northwest. The depths attainable by the equipment already in use are not sufficient to prove or disprove the existence of porous horizons capable of producing commercial oil, but the results obtained confirm the deductions made from the surface studies. That must be the function of deep drilling operations and it has been recommended that the area be tested to a depth of 5,000 ft. or more if necessary.

Above — this picture of part of the Kasim camp of N.N.G.P.M. shows that even close to shore, it is necessary to clear away jungle vegetation. Below— despite the fact that Babo comes under the classification of a temporary camp, it is laid out extremely well and is well equipped with both hospital and recreational facilities.



Producers' Strike May Restore Crude Prices

Growing Volume of Underpriced Oil and Failure to Liquidate Excess of Motor Fuel Stocks Held Responsible for Cut—Correction of Causes Needed for Sustained Equilibrium.

WIDESPREAD cuts in price of crude oil in principal producing fields of the United States during the second week of August broke upon the industry with the suddenness of a summer thunderstorm. Under the circumstances it is not surprising perhaps that they released a great amount of political heat lightning. Like the meteorological phenomenon referred to, however, ample warning had been given in the gathering of dark clouds which have been collecting over the price structure for a long time past, becoming darker and more menacing during recent months. To carry the simile a step further it is quite possible that the storm itself may clear the air if the causes of the price reduction are examined frankly and if a concerted effort is made to remove them As the shutdown ends, the former price level has been restored but no permanent remedy has been provided.

In most processing industries there are three main divisions: first, the producers of raw material; second the manufacturers who convert it into marketable products; third, the distributors who purvey these to the consuming public. The fact that in the oil industry single companies in some instances appear in all three roles does not affect the interdependence of the groups. The prominence of these integrated companies may give those outside the industry an exaggerated impression of their importance, but in reality they are greatly outnumbered by those whose interests are confined to production, processing or marketing.

To remain in business the raw material producer must receive a price sufficient to cover his cost of operation, a fair return on his investment and, in the oil industry, an allowance that will cover the gradual depletion of his wells. Nobody contends that an average price of a dollar a barrel for crude oil is excessive for these requirements. In many cases it barely covers operating costs and many wells have been produced at an actual loss with prices higher than those recently in effect.

The processor, must recover the expense of his manufacturing operations and obtain his profit, if any, out of the margin between the price of crude and the wholesale price of products. The inadequacy of this margin has been a chronic condition for the past several years. When the industry was under government control during the life of the NRA one of the first moves made was to raise the badly depressed price of crude to the dollar a barrel level. This was accomplished through united action by the oil companies with the approval and direction of federal authorities. At that time a study was made of the proper relationship between the price of crude and the price of products. It was decided that a reasonable ratio was 18 to one. In the price schedule drawn up at that time the basic price of crude was placed at $1.11 per bbl. and the wholesale price of gasoline at 6½ cents per gallon. While the crude price schedule was promptly made effective, neither during the period of direct federal control nor since has the corresponding gasoline price prevailed in actual operation.

The troubles of the refining branch of the oil industry have been the subject of complaint and discussion for the past several years. The situation has been particularly difficult for those refiners who had no crude supplies of their own but were compelled to purchase crude and to sell their products to others for distribution. Their only chance of profit depended upon the margin between crude and products prices. When this was too narrow to cover costs many of them were forced out of business, temporarily or permanently.

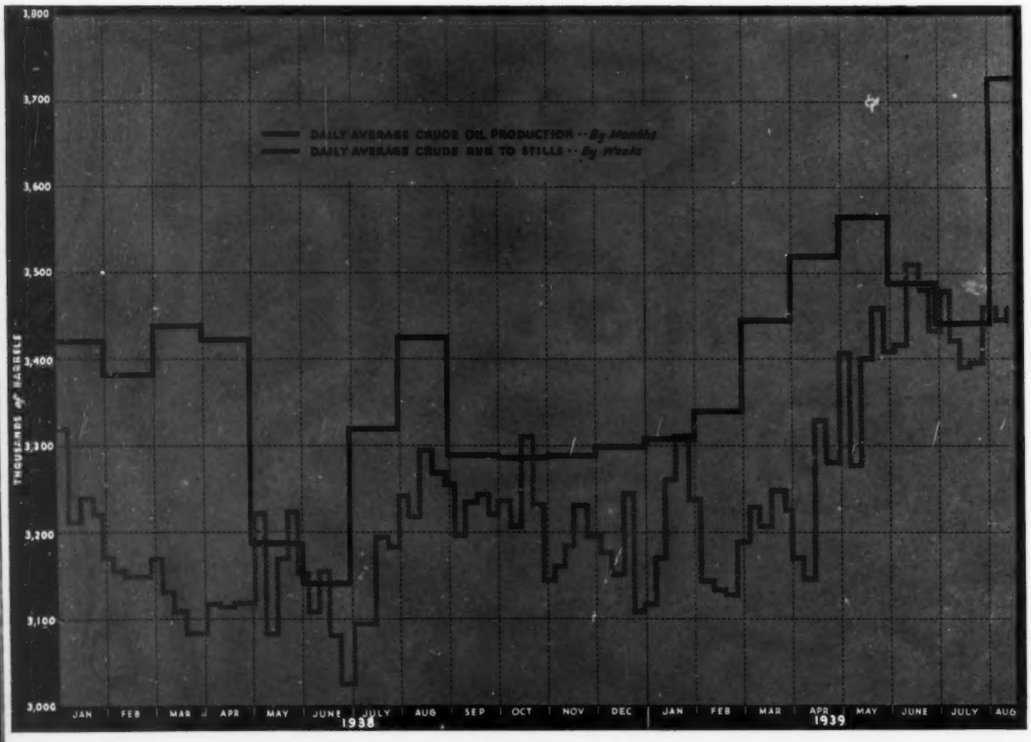
Distributors of petroleum products operate on margins between wholesale and retail prices which are more or less generally recognized in trade practice. The reasonableness of these margins is a subject of frequent dispute but as they move up and down with changes in wholesale and retail quotations, the distributor is less affected than others by fluctuations in the price of crude and the wholesale price of gasoline.

Two questions are often asked by those outside the industry and even by some producers who, naturally enough, view the price situation solely from the angle of its effect upon themselves; "If the price of gasoline is too low why don't the big companies raise it?" and "If this condition of unbalance has existed for three of four years why wasn't action taken sooner?"

The first of these questions presupposes that the larger oil companies have it in their power to fix the price of gasoline. If this were true the disparity between the prices of crude and products would have been remedied long since. At various times different major companies have endeavored to institute higher prices for motor fuel. A few months ago Harry Sinclair, head of the Consolidated Oil Company, made a spectacular and widely advertised move in this direction by announcing a half-cent increase in the wholesale gasoline price in all Consolidated sales territory, which includes most of the United States. None of these moves has gone far enough to be generally effective. Why?

Away back in freshman economics we were taught that in a competitive system price is determined by the relation of supply and demand. Even today, in spite of the fact that among certain advanced political theorists such principles are regarded as outmoded, it is significant that all the powers of govern-

U. S. crude oil production in relation to runs to stills.



Harold L. Ickes, Secretary of Interior, at first declared "It is none of our business", but a few days later contradicted himself by saying that the action of the six states in having to shut down the fields to raise crude prices makes federal control of the oil industry more necessary than ever!

ment are not able to keep the prices of commodities, such as farm products for example, from falling when there is an oversupply.

Looking further into the simple economic formula mentioned above we find that while it is true that supply and demand regulate price it really is the buyer who has the final say in the matter because he controls demand. If he considers that a particular article is priced too high he can refrain from buying it. If the number of those who adopt the same line of action is great enough the price is certain to come down. This has been evidenced often enough by the success of so-called buyers' strikes which usually are not organized movements but represent a common reaction on the part of a great number of individuals.

A characteristic of Mr. Average Buyer is that he wants to get his goods as cheaply as he can and certainly as cheaply as his next door neighbor. He may sympathize with the local marketman who complains of chain store competition but if even a small saving is to be made the chain store is likely to get his trade. Testimony to the prevalence of this trait is to be found in the multiplication of chains notwithstanding legislative efforts to suppress them.

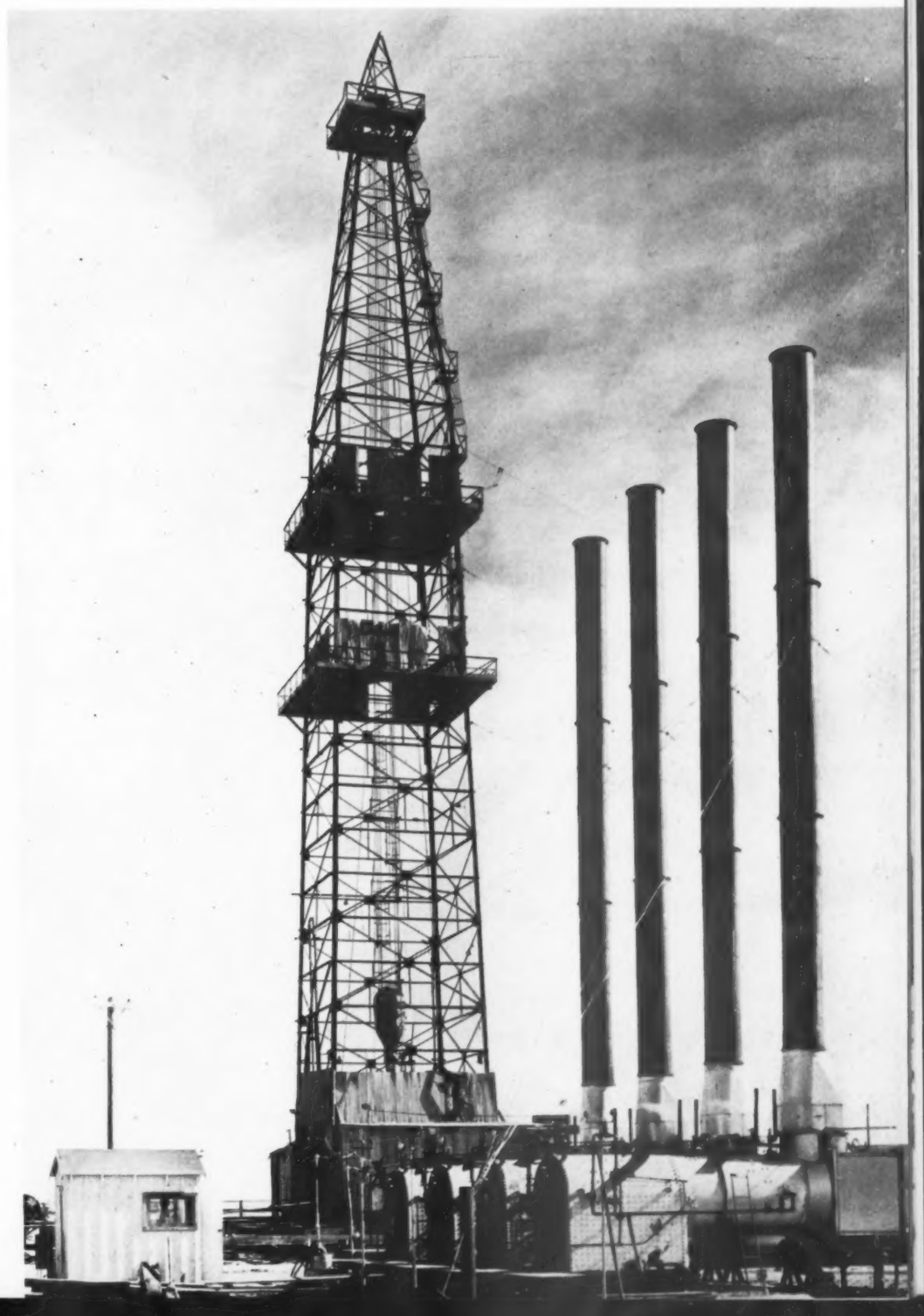
As a consequence of this tendency to buy in the cheapest market the lowest seller makes the price. Volume enters here as a factor. If the prevailing price of beefsteak in our town is 50 cents a pound and one dealer begins offering it at 40 cents the others may ignore his bid for trade, but if more and more 40 cent signs appear in the windows, the chances are that soon everyone will be selling at that level because there is nothing the merchant dreads more than the loss of his regular customers.

Experts in market research say that there is no fixed rule as to the amount of this competition needed to bring down the existing price structure. Under certain conditions and in certain localities as little as two percent of total volume may upset prices. Students of the subject do agree, however, that when 10 percent or more of a given commodity is being sold below the previously established basis the whole price level is almost certain to come down. As cutting spreads the new price becomes the true market barometer and the old quotation is only a nominal one.

All this of course is the most elementary kind of economics but it serves fully to explain what has happened in the oil industry. Not only that but it points the way to the action that is necessary to avoid a recurrence of the developments within the past thirty days that have led to such determined action by oil producers and state conservation authorities.

Price cutting has been a besetting ailment of the oil trade. Price wars are contagious and costly. Under the most favorable market conditions a certain amount of products are

California has not been affected by the situation in Texas and the Mid-Continent.



offered below posted prices in order to find a buyer. Under the most stringent state laws there is a certain amount of unauthorized production. When new flush fields come in and are allowed to flow without restriction the extent of cut price offerings naturally increases.

During the past six months the amount of crude oil sold below posted prices and so entering into products that could similarly undersell has been growing more or less steadily. Illinois has been pilloried as a conspicuous offender but in Texas, Arkansas, Louisiana and other states a large quantity of crude was being sold at prices from 15 to 40 cents below posted quotations. The exact volume of such underpriced crude cannot be determined but by August 1st, 1939, it certainly was well above the 10 percent danger line and in some fields probably was nearer 25 percent of total production. Under these conditions the reduction of posted prices was a recognition of conditions that no longer could be ignored.

This growing flood of underpriced crude helps to answer the second question posed above and to explain why the break came in August, 1939, rather than a year or more earlier. In 1936 and 1937, although production and runs to stills steadily exceeded the figures of estimated requirements put forth by the Bureau of Mines, the day of reckoning was postponed by an unusual growth in motor fuel consumption. In 1936 the increase over the previous year was over nine percent and in 1937 this high record was surpassed by slightly over 11 percent.

With cheerful optimism the industry assumed that this gain would continue during 1938 but the industrial recession of that year dashed these hopes and the increase of around 1.5 percent over the preceding year was attained only through an exeptional temporary rise in export demand. Failure to check runs to stills caused motor fuel stocks to rise to 93,000,000 bbl. by April, 1938, and to remain above 75,000,000 bbl. at the close of the year. While crude stocks in storage were being reduced the crude was being converted into unsold gasoline, a condition much more threatening to market stability.

Warnings of the danger to both crude and products prices from this situation were not lacking, as the pages of WORLD PETROLEUM and other oil journals can testify. In January last an eminent statistical authority pointed out to readers of this magazine that to bring about a gradual lowering of motor fuel stocks to manageable proportions crude production should not exceed 3,373,000 bbl. daily during the first half of the year and that runs to stills should be held to 3,180,000 bbl. daily during the same period. This forecast made allowance for the increase in motor fuel demand which actually has taken place. While statistics of daily production show an average of 3,344,000 bbl. from January to the end of July runs to stills were 3,308,000 bbl., while gasoline stocks, so far from showing a reduction at the beginning of August, were over 1,000,000 bbl. above their total a year earlier.

A more threatening change in the situation made itself manifest in late July and early August when both production and runs to stills took a sharp upward turn. Runs to stills rose above 3,400,000 bbl. daily in the latter part of July while crude output established a new high record with a daily average of 3,909,000 bbl. for the week ending August 5th.

The cumulative effect of these factors—failure to liquidate excess stocks of gasoline during the season of heavy demand, excessive runs to stills and an increasing volume of crude products pressing on the market at cut prices—provide ample explanation of the recent price drop. It was inevitable that refining and marketing organizations soon or late would call a halt on conducting their business at a loss. As it was their action was delayed until the losses threatened to become ruinous. If the reduction had not taken place in August it would have had to come later providing the same conditions that have been operating during the first seven and a half months of the year were allowed to prevail. Perhaps it will prove easier to cure the distemper now than it would have been three or six months later.

While it may suit the purposes of those with political axes to grind to raise the cry that prices were slashed by major companies in the effort to drive smaller competitors out of business there is nothing in the record to support such a claim. Aside from the obvious fact that the larger a company's volume the greater must be the cost to it of doing business at a loss the day has long since passed when there was a possibility of an oil monopoly in the United States unless it should be instituted by the federal government itself. No single company has more than a small percentage of the business in any locality.

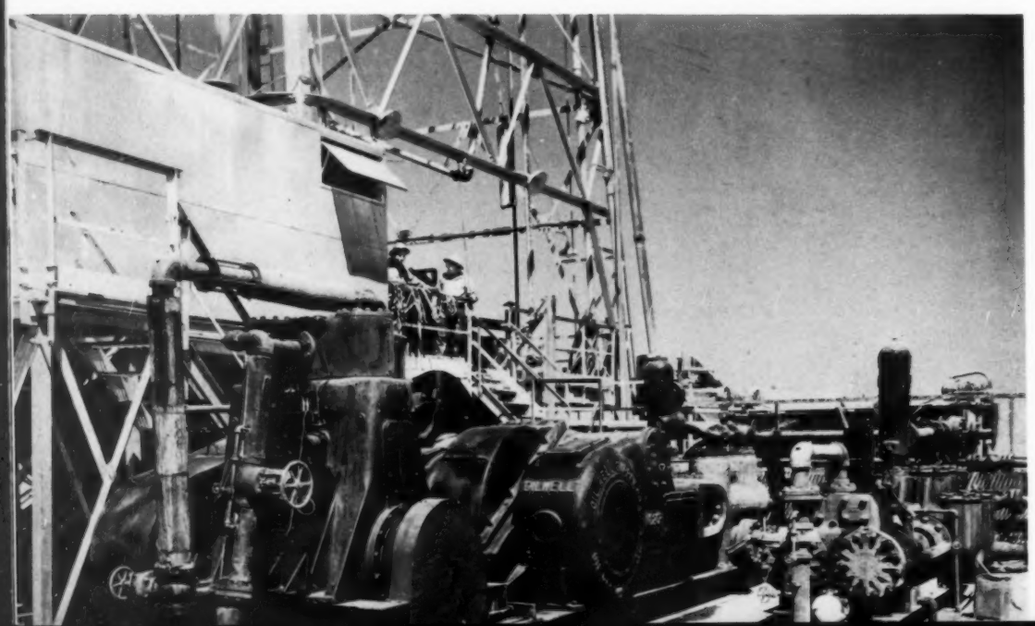
So well recognized is it that a fair return to the crude producer is the foundation of oil trade prosperity that strenuous efforts have been made repeatedly during the past five years to support the crude price structure when it appeared to be endangered. The great majority of the industry, including large companies, small companies and individuals, have cooperated whole heartedly in such movements and have supported drastic action on the part of state conservation officials to make them effective. Of the relatively small minority who have contributed to the rising tide of underpriced crude and products some undoubtedly were willing to sacrifice the general welfare to their immediate selfish advantage but others were driven by the compulsion of maturing obligations which they saw no other way of meeting. In either case the effect of course was the same.

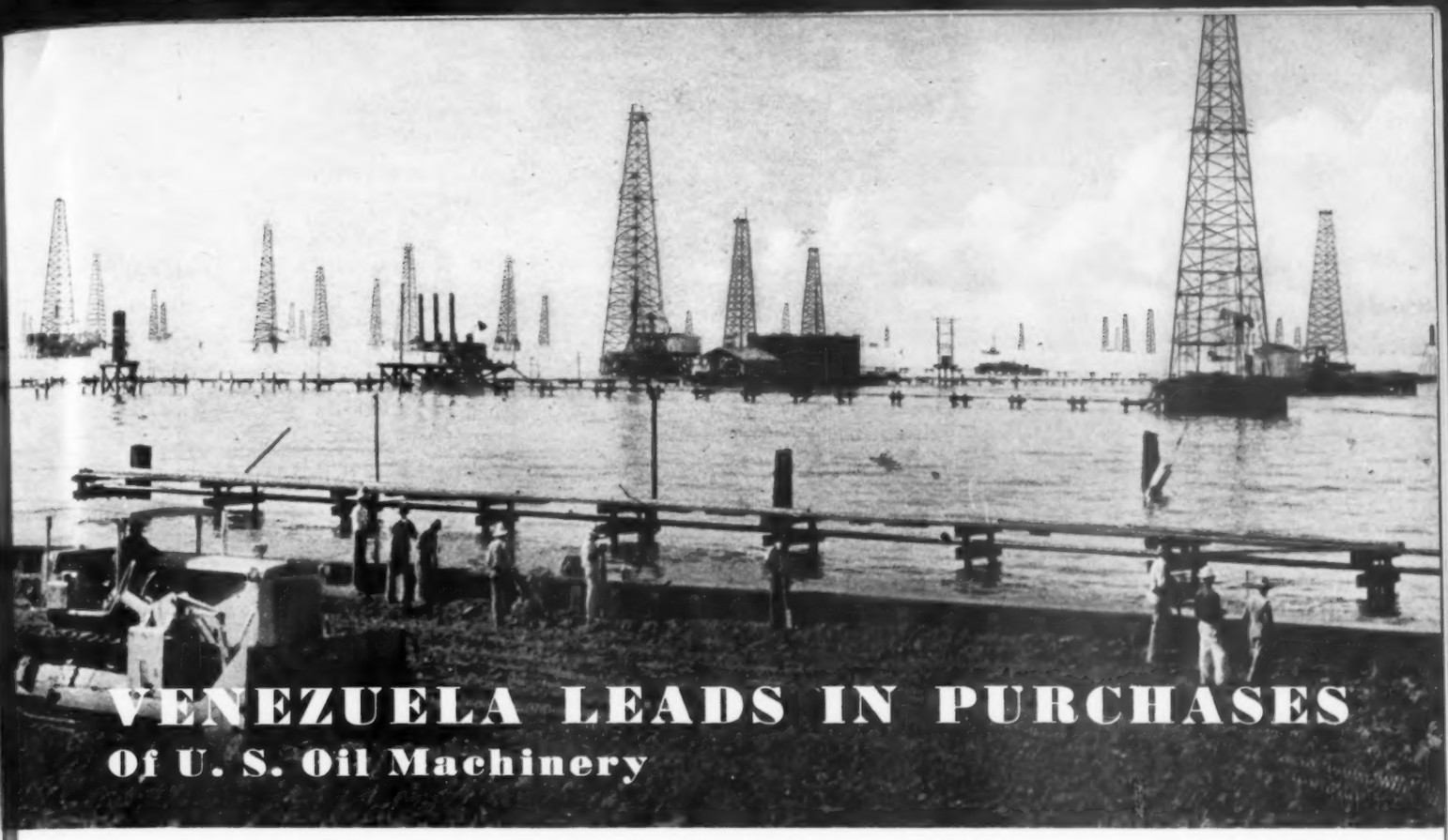
Prompt action by the authorities of principal producing states in ordering a general shutdown presents a phenomenon relatively new in American industrial life. In effect it is a sellers' strike. If generally observed it will not have to continue long to bring about a restoration of former prices by bringing supply far below current demand.

Leaving out of account the Pacific Coast which was not involved in the developments of the past month cutting production in half has resulted in a big gap between daily production and consumption. During its fifteen days duration the shutdown has prevented the output of roundly 20,000,000 bbl. which otherwise would have been produced. Runs to stills have been maintained but stocks have been reduced and shortages in crude supplies have made themselves felt at various points. The flow of underpriced crude has been checked temporarily. Restoration of crude prices to their former level has smoothed the situation for the time being.

To prevent a recurrence of the trouble, however, and to establish a lasting improvement in the situation, it will be necessary to impose sufficient restraint upon output to prevent the accumulation of further unneeded stocks and to reduce materially the flow of cut price crude and products. These are the conditions that must be remedied before anything like sustained stabilization can be attained. Something can be done in this direction by a vigorous enforcement of existing laws and by cooperation of certain states where control has been notoriously lax. A more difficult problem is presented where a lack of regulatory authority exists, as in Illinois where production was pushed up to a new high record at the very time when other states were closing down. The pessimistic view of the recent action regards it as a mere flash in the pan. The most hopeful possibility is that the demonstration of sentiment provided by the important producing states joining in the movement may give a strong impetus to efforts to prevent the wasteful operation of flush fields and to curb unauthorized production that can operate only to undermine the market structure.

Prompt action by state authorities in ordering a general shut down is relatively new in America





VENEZUELA LEADS IN PURCHASES
Of U. S. Oil Machinery

High Volume of Oil Equipment Exports Set in 1938 Maintained in First Half of 1939 — In Three and a Half Years Venezuela's Imports of U. S. Drilling and Refining Apparatus Have Amounted to $20,000,000.

IN THE PAST ten years, Venezuela's purchases of oilfield and refinery equipment from the United States have amounted to $31,555,484. In the five years 1934–38 inclusive, the declared value of oil machinery exports from the United States to Venezuela was $22,525,595, representing nearly 20 percent of the stated value of $122,264,437 for all oil machinery shipped from the U. S. A. to other countries during this period. If refinery equipment exported to Netherland West Indies, primarily for use in treating Venezuelan crude, be included the total value of American sales of equipment due to the Venezuelan oil industry rises to nearly $34,000,000, or more than one-quarter of all exports falling within the classification of oil machinery during this half decade.

How far Venezuela has outdistanced other countries in its importations of oil machinery is shown by the following tabulation taken from the records of the U. S. Department of Commerce. The figures give, in dollars, declared value of exports to the principal markets for oil industry equipment and also the total for all countries.

TABLE I

EXPORTS OF OIL MACHINERY FROM U. S. 1934-38

Venezuela	$22,525,595
Neth. India	12,478,554
Neth. W. Indies	11,316,827
Trinidad	8,238,908
Iran	5,201,504
Colombia	4,989,932
All others	57,513,117
Total	$122,264,437

Official trade statistics list only specialized oil machinery under oilfield and refinery equipment. They do not take account of a vast amount of supplies and machines which are used by the petroleum industry either in field, refinery and transport operations or in subsidiary but essential activities. If figures were available covering all importations for which the oil industry is responsible in a country like Venezuela the full value would be three or four times the sum shown under the direct classification of oil machinery. The figures given, however, convey some indication of the size of the oil industry and its importance in providing business for machinery manufacturers and employment for their workers. As a comparison of the relative importance of various export markets they are reliable since all are affected to approximately a like extent by the same factors.

A survey of United States oil machinery exports reveals two interesting developments within the past decade. One of these is the remarkable growth that has taken place and, more particularly, the astonishing jump recorded during the past two years. In 1937 the increase over 1936 was more than $16,000,000, or 86 percent. On top of this unprecedented gain, 1938 showed a further rise of over $5,000,000, or another 15 percent. Oil machinery exported from the United States in 1937 and 1938 was greater in value than for the six years preceding, while the total for 1938 was four times that for 1931.

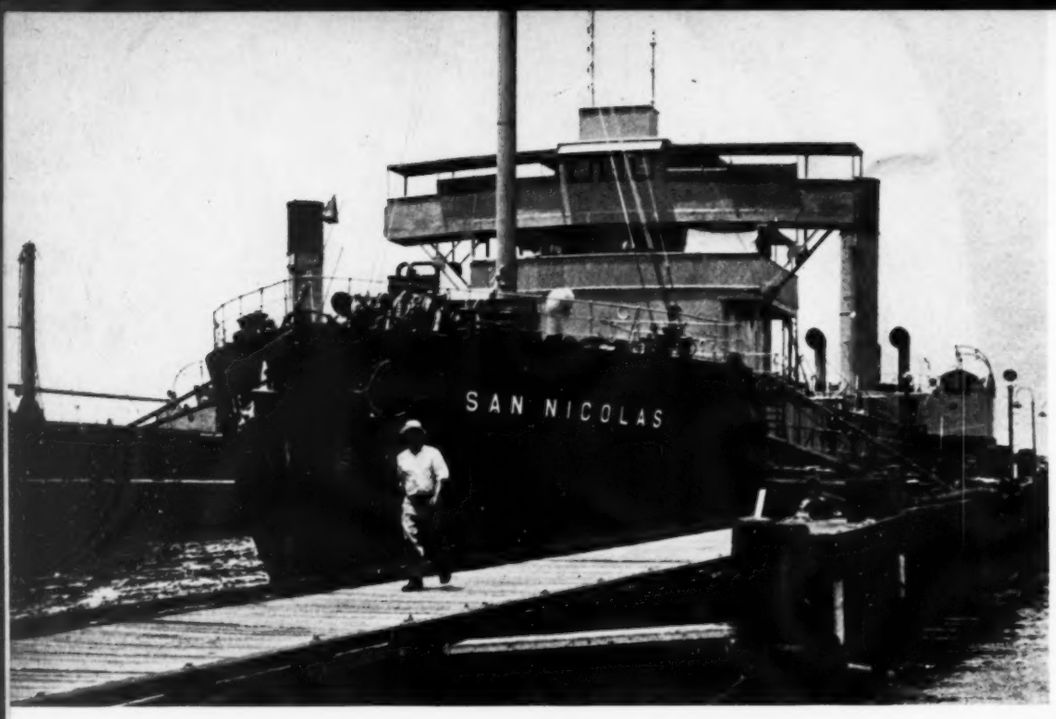
A second shift in the figures reflects the great development program that has been put under way in all parts of the world outside the United States during the past two years. Prior to 1937 the value of exports of drilling machinery was less than that of "refining and other" equipment. In 1937 this relationship was reversed—for the first time drilling machinery showed a greater value than refinery and other equipment, and in 1938 this excess was over $6,000,000, despite the fact that the value of refinery and other equipment was higher than in any previous year.

TABLE II

U. S. EXPORTS OF OIL MACHINERY

Year	Drilling Machinery	Refining and other Equipment	Total
1931	$3,557,259	$6,771,845	$10,329,104
1932	1,680,271	2,741,247	4,421,518
1933	2,692,279	4,221,678	6,913,957
1934	6,138,510	6,871,650	13,010,160
1935	6,745,208	8,054,182	14,799,390
1936	8,762,253	10,065,558	18,827,811
1937	18,513,062	16,671,459	35,184,521
1938	23,222,435	17,219,920	40,442,355
1939 (Jan. -June)	10,365,699	10,453,201	20,818,900
Total	$81,676,976	$83,070,740	$164,747,716

In the case of exports from the United States to Venezuela the same condition—that



Venezuela's increasing production is being accompanied by greater purchases of oil field equipment.

is, an extraordinary increase during the past two years—is observable. During the nineteen twenties, when production in Venezuela was expanding rapidly, the country's purchases of oil machinery in the United States showed a corresponding growth, culminating in 1929 in a total of $4,056,715. The industrial depression beginning in that year, with the attendant serious deflation of oil products' values, was reflected in the decline of demand for oil machinery. In 1932 the total value of imports to Venezuela from the United States was down to less than $500,000. From that low point the business has grown steadily with a particularly high increase in 1937 and 1938.

Table III shows the value of oil machinery exports from the United States to Venezuela, classified according to the practice of the U. S. Department of Commerce.

TABLE III

EXPORTS OF OIL MACHINERY FROM U. S. TO VENEZUELA

Year	Drilling Machinery	Refinery and Other Equipment	Total
1931	$353,845	$391,140	$744,985
1932	225,713	209,144	434,857
1933	845,831	510,271	1,356,102
1934	1,894,174	926,740	2,820,914
1935	2,439,671	999,733	3,439,404
1936	1,968,197	1,276,362	3,244,559
1937	4,534,018	1,539,839	6,127,857
1938	5,959,783	933,078	6,892,861
1939 (Jan.-June)	2,351,136	1,043,053	3,394,189
Total	$20,572,368	$7,883,360	$28,455,721

During the first half of 1939 the export of oil machinery has continued in unabated volume. The total value of such exports has reached nearly $21,000,000, divided almost equally between drilling machinery and refining and other equipment. As in previous years, Venezuela has maintained its leading position as a purchaser, being followed by Netherlands India in second place. Further down the list there have been some notable changes in position as shown by Table IV:

TABLE IV

EXPORTS OF OIL MACHINERY FROM U. S. (Jan.-June 1939)

Country	Value
Venezuela	$3,394,189
Netherland India	2,406,000
Colombia	2,218,841
Argentina	2,151,129
Netherland West Indies	2,112,928
Palestine	1,719,087
Others	6,816,726
Total	$20,818,900

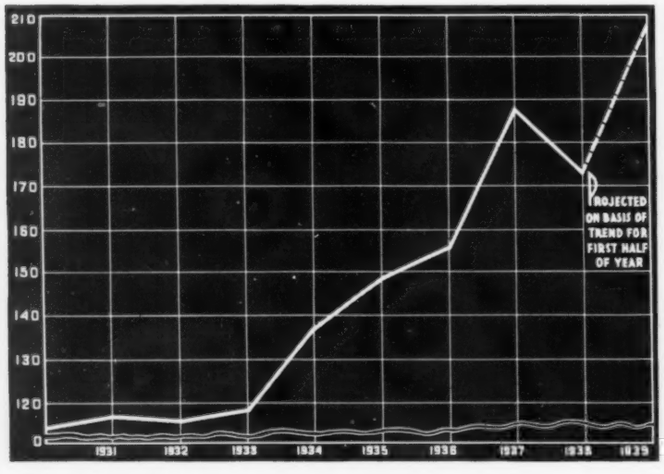
As appears from Table IV, Colombia has risen to third place and Argentina to fourth, displacing Netherlands West Indies and Trinidad in those positions, while Palestine has taken a place temporarily among the leaders as a result of shipments of material and equipment for the refinery now in process of erection at Haifa. Netherland West Indies remains the leading market for refinery equipment, with imports from the United States exceeding $2,000,000 in the first half of 1939.

British India, Trinidad, Canada and Egypt also have been important markets for American oil machinery during the first half of the current year, with imports between $500,000 and $1,000,000 each, but exports to Mexico, formerly among the important purchasers of drilling and refinery equipment, amounted only to $58,771 for the entire six months.

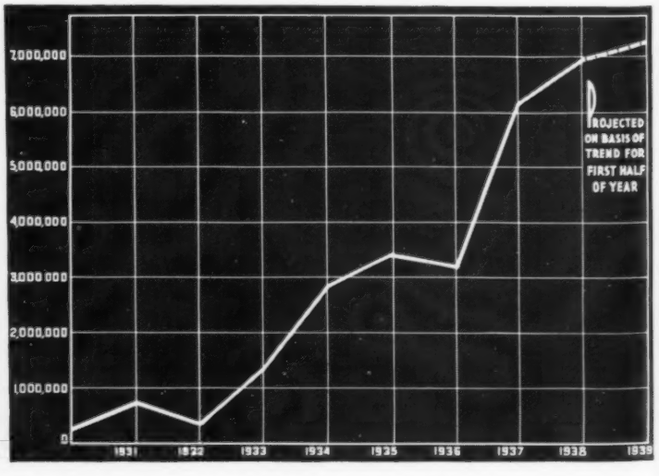
A country which ordinarily does not figure as an importer of drilling machinery is the Dominican Republic, which in May of this year took nearly $150,000 of such equipment in connection with wildcat tests now being made there.

In general the statistics of oil machinery exports from the United States for the first half of 1939 indicate that the expanding trend of export demand which has been so strikingly in evidence during the past two years is being maintained. They reveal that South America is far in the lead as a market for such equipment, with the Far East and Near East occupying very important positions in this trade.

VENEZUELAN OIL PRODUCTION 1931 - 1939
In Thousands of Barrels



VENEZUELAN EQUIPMENT IMPORTS
From U. S. A. 1931 - 1939, In Dollars



WHAT OF CANADIAN OIL?

By H. G. Cochrane

Alberta's Reserves Estimated at 526,000,000 Bbl. Turner Valley Largest Reserve Field in British Empire—High Cost of Oil Transport Retards Nationwide Distribution—Pipelines to Great Lakes or Pacific Ports Possible.

DEVELOPMENT of the Turner Valley field in Alberta, Canada, has proceeded rapidly during the past three years, making it one of the 15 leading oil-producing countries outside of the United States. Canada produced less than 500,000 bbl. in 1927 and by steady development it was possible to raise the output of the naphtha wells to 1,507,931 bbl. in 1936—but production of crude oil was still negligible.

Discovery of heavy petroleum in Turner Valley during 1936 resulted in intense development of that field and production was increased to 6,936,479 bbl. in 1938. Today there are over 80 wells producing crude oil and 105 naphtha wells in Turner Valley, the production from which, together with other smaller fields in Alberta, is now more than sufficient to supply the needs of the three Prairie provinces and eastern British Columbia. Recoverable oil reserves are estimated at 526,000,000 bbl., compared with 150,000,000 bbl. reserve in Trinidad—hitherto the most important source of oil in the British Empire. Adequate transportation will be provided when Turner Valley and other likely structures are proven to have sufficient reserves to supply domestic demand long enough to amortize cost of a pipeline.

During the year past Alberta produced 97.54 percent of Canada's total output, 96.46 percent being from Turner Valley and 1.08 percent from Red Coulee, Wainwright-Ribstone, Taber and Moose Dome in Alberta and a little from New Brunswick. Western Ontario produced 2.46 percent.

At the end of 1938, Turner Valley field extended five miles north and south along the

Canadian National Railways

Burning waste gas in the Turner Valley field, Alberta.

western flank of the valley's southern end and had an approximate width of one-and-a-half miles. In December, the Home-Millarville No. 2 came-in from 8,200 ft. some 12 mi. north of the proven field. Completion of this well is held to indicate an extension of the producing area to a total length of 17 or 18 mi., curving northwest, and it may yet be proven another seven miles northwest to the point where Dr. G. S. Hume, Dominion Geologist, says that the structure plunges sharply to the north and places the producing formation at too great a depth for economical development.

Each acre of the Turner Valley field has a rated potential production of some 55,000 bbl. Assuming the proven area to be 17 mi. by 1½mi., the Turner Valley field covers 26,320 acres and would have an ultimate potential yield of 1,467,600,000 bbl. It is estimated that 23,300 bbl. are recoverable per acre, by current production methods. Taking a conservative figure of 20,000 bbl. recoverable per acre, the anticipated recovery from this field would be 526,000,000 bbl.

The field may prove to be even larger. Okalta No. 6, which had been drilled to 10,209 ft. only to obtain brine from the lower limestone formation, was plugged back to the upper lime for a satisfactory production of 38 to 39 deg. Baumé crude—heaviest in Turner Valley. This well would indicate a further extension of the producing area to two miles in width. There is geological support to the opinion that the field will be extended north to a length of 24 mi., while it may be extended also to the south, although plunge of the structure may prevent economical development at the present time.

An encouraging production of 24-deg. Baumé oil has been obtained at 2,034 ft. by the Blackfoot-Ribstone well, 30 mi. southeast of Wainwright, while North Taber Royalties No. 1, 30 mi. east of Lethbridge, is also attracting attention. Other areas being tested include the Crow's Nest Pass, where two holes are being sunk near Lundbreck; the Altoba well, Clearwater River, 20 mi. southeast of the Ram River well; Home-Brazeau test in the Brazeau area; Banner well, Highwood area; Moose Dome, 30 mi. west of Calgary; and the Milk River and Del Bonita wells along the international boundary.

One of the most promising structures is the Grease Creek field, 45 mi. northwest of Calgary, where a test has been started by Imperial Oil Company and Grease Creek Petroleums (associated with West Turner Petroleums, which has wells in Turner Valley). Several large companies have been interested in this structure, including Standard Oil Company of California. Drilling will be by the cable-tool method down to 3,500 ft. or 4,000 ft., and if it is found necessary to go deeper rotary will be substituted.

PRORATION

A year ago it became apparent that Alberta production would soon exceed Prairie consumption and Royalite (Imperial Oil Company subsidiary), which produces about a quarter of the Turner Valley output and transports the field's entire output through its pipeline to Calgary, attempted to prorate the output of all wells so that each well would get its fair share of the market. Later in 1938, the Alberta Petroleum and Natural Gas Conservation Board was formed to take over these duties and to apply other conservation measures as well—such as prevention of gas waste and limiting development on any 40-acre block to one well.

With the appointment of the conservation board the total quantity of allowable oil production was distributed among crude producers by application of a formula which included the factors of gas/oil ratio, bottom-hole pressure, well spacing, and measured flow through a two-inch nipple. On September 2nd, 1938, the board issued its first allotment of allowable production, which, based on market demand as existent on that date, was to total 28,000 bbl. per day. Frequently-revised allotments followed later to take care of newly completed wells and changes in market demand. Further drops in the market, with consequent reductions in allowables, appeared until by October 28th it was down to 11,500 bbl. After the close of the winter season the allowable rose appreciably.

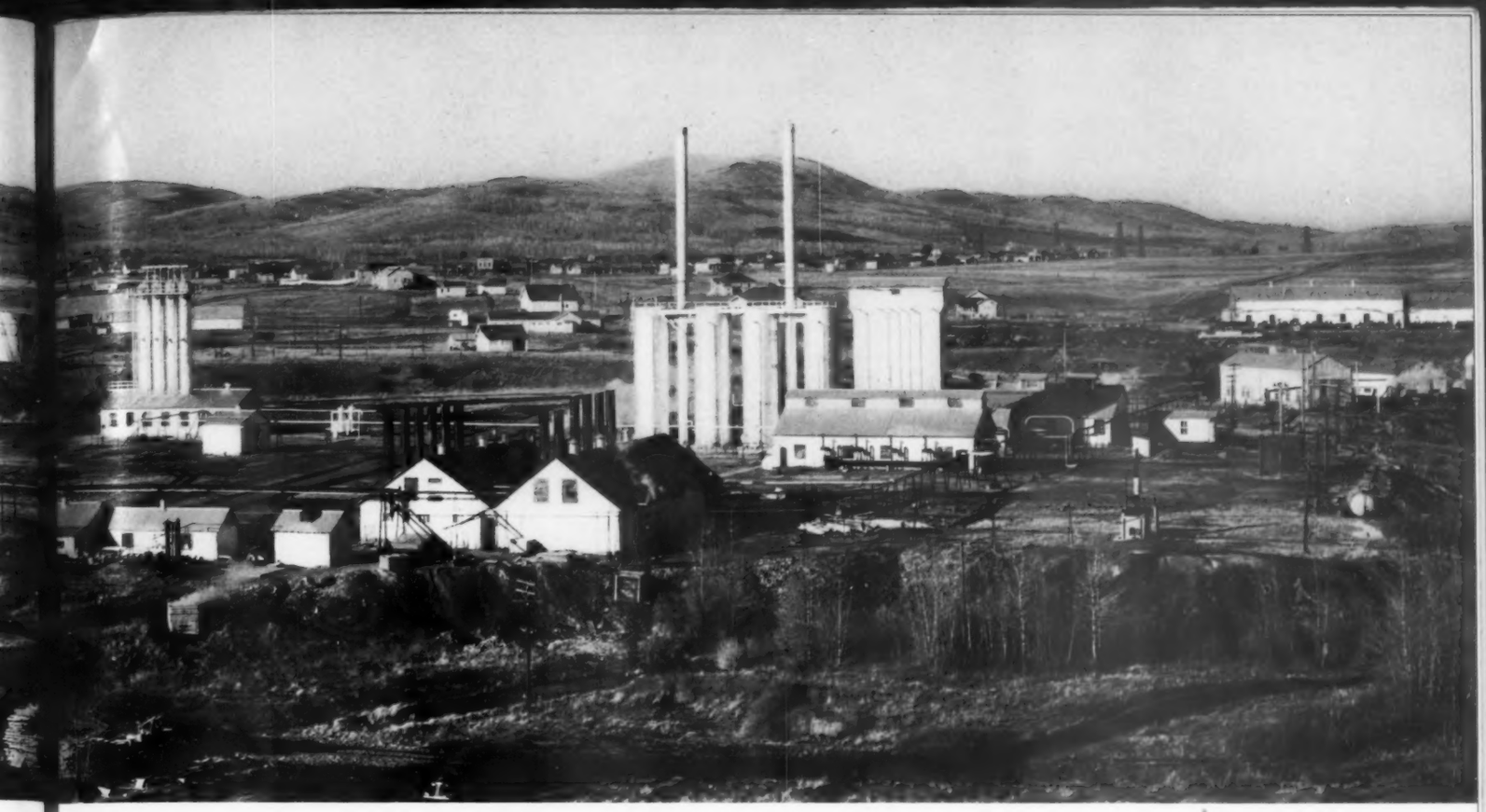
The first gas conservation order following the act just summarized was issued by the board on November 30th, to become effective on December 7th, which gives a total monthly allowable of all gas wells of 3,240,687 mcf. This remained in force until mid-January, 1939, when production was further restricted to the quantity used for lighting, heating, and generation of power. The board has provided for "any further amount which is returned to the earth in such manner as may be approved by the board." For the purpose of the order, the definition of "gas well" is any well at which the production of oil in liquid form produced and recovered at the well does not exceed one barrel per 31,000 cu. ft. of gas.

The noticeable drop in Canadian production for October, 1938, is due to the drastic reductions made in September and October for allowable daily production totals which not only affected the October figure, but also reacted on those of the entire winter season, thereby reducing considerably the total for the year.

Alberta oil production is secured approximately as follows: 85.5 percent Turner Valley crude oil recovered from the limestone, 10.0 percent Turner Valley naphtha recovered from the limestone, and 1.5 percent Turner Valley crude oil recovered from shallow horizons

H. Pollard, Calgary

A settlement in the central part of the Turner Valley field — Little Chicago



Royalite Plant No. 1 looking northwest along the Turner Valley field

above the limestone, plus production from other Alberta fields.

MARKETS

Last year the Prairies consumed at the average rate of 21,300 bbl. of oil per day over the whole year. Of this total, Turner Valley provided 18,450 bbl. or 87 percent, and of this amount approximately 16,100 bbl. per day came from the crude-producing wells, the balance being from naphtha wells.

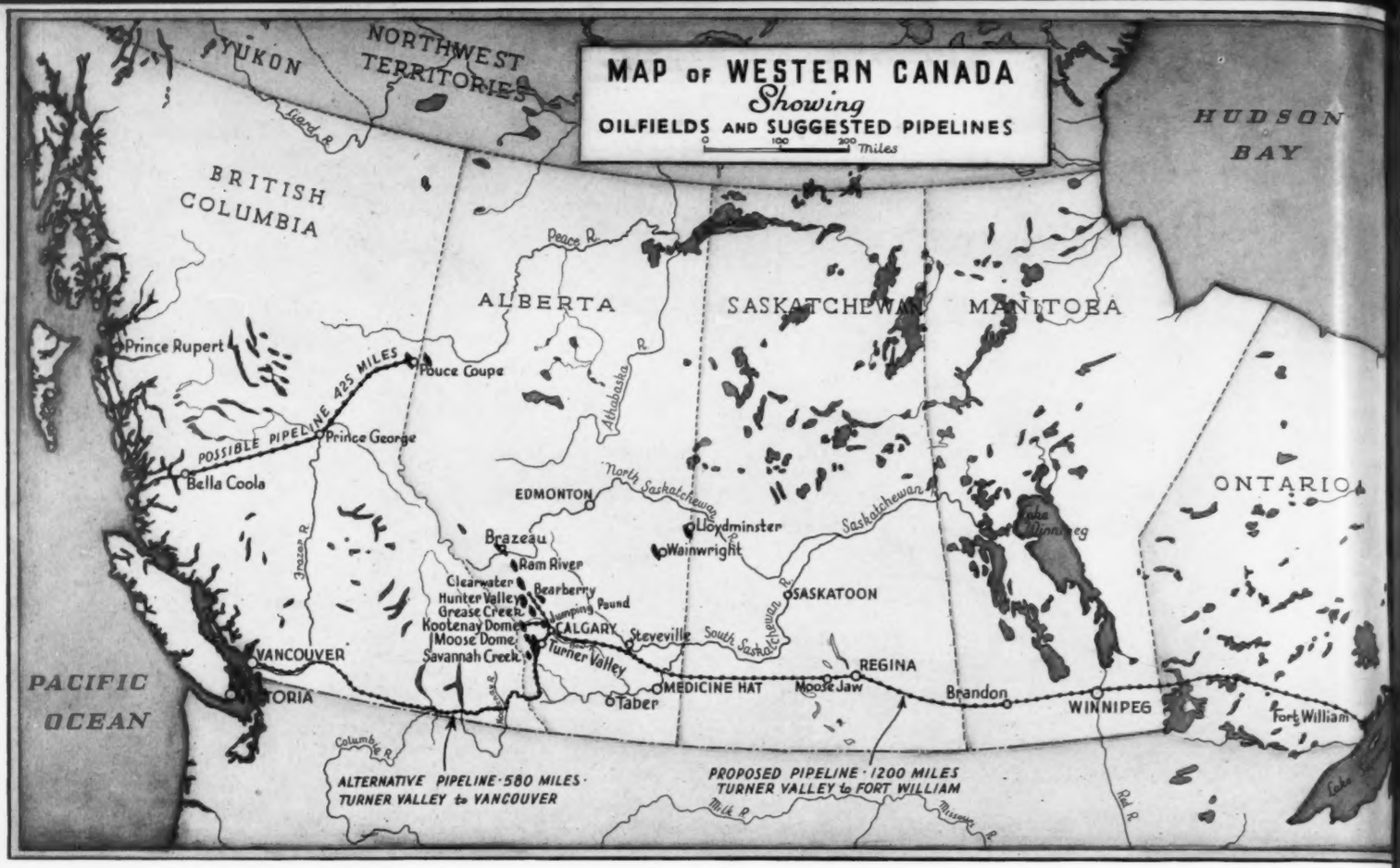
The rate of 18,450 bbl. mentioned varied between about 10,000 bbl. per day in the winter to around 30,000 bbl. daily during the peak consumption period in the late summer. While there was some evidence of strain on the producing wells during this peak period, which if long continued would have resulted in abnormal depletion and consequent reduction in ultimate recovery, it appears to be the opinion of experts that the present 80 crude wells are capable of producing steadily at an average rate of between 30,000 bbl. and 35,000 bbl. per day without any adverse results.

On an accompanying graph the average daily production for each month from crude wells only is shown from July, 1937, to May, 1939, and projected to December, 1940, assuming Prairie consumption to be substantially the same, and imports from Montana and other states being displaced by the Turner Valley product. Another line shows the restricted potential production to-date for each past month, arrived at by multiplying the number of crude-producing wells by 250 bbl. per day which is approximately the average allowable per well over the whole year under present conditions—projected ahead for future months of 1939 and 1940, assuming present rate of drilling of new wells to be continued. With some 30 new wells drilling in Turner Valley at the present time and announcements of intentions by various producers to drill some 25 or 30 more this year, this seems to be a reasonable estimate.

The divergence of these lines shows that on these assumptions there will be a surplus potential over and above Prairie market requirements built up by late in 1940 of some 20,000 bbl. per day. This may not turn out to be an accurate forecast. The size of the Prairie grain crop is the dominant factor in determining what the market for petroleum products will be in the three Prairie provinces. Acreage sown to grain has decreased slightly from 1938. On the other hand, rainfall was well above normal up to the middle of July, and this together with the improvement in rainfall last year lends hope that the Canadian West is at last emerging from the prolonged drought cycle. A 400,000,000 or 500,000,000-bushel wheat crop in 1939 might easily result in the assumed average daily consumption for 1939 of 21,300 bbl., similar to that of last year, increasing to an average of 23,000 bbl. or 24,000 bbl. daily. But with surplus potential building up at such a rate, and with the consequent dilution of the monthly returns on oil royalties, it is evident that an outside market must soon be found beyond the Prairie provinces.

At the hearings in Calgary of the conservation commission last winter, six or seven expert geologists gave their opinion on oil reserves proved to-date in Turner Valley. Estimates ranged all the way from 100,000,000 to 250,000,000 bbl., but it was significant that the experts testifying on behalf of the pipe-

Lane-Wells Co.



line company who wanted to establish a short life for the field and thus justify their transportation charges, gave the lowest figures. Since the Turner Valley proven area has recently been somewhat extended, while progress has been made on proving other structures, the total is estimated at a considerably higher figure at the present time.

On the other hand, estimates of oil reserves on probable oil land, which is defined as "land lying close to producing tracts which from all geological data, though not proven, should show a continuation of the producing area," having been given by eminent geologists as around 700,000,000 bbl.

Turner Valley produces a comparatively light oil, between the limits of 40 deg. and 50 deg. Baumé, yielding a high percentage of gasoline distillates and light fuel oils with a relatively small percentage of the heavier bottoms suitable for oil-burning locomotives and ships' bunkers. It fits in nicely with Prairie requirements where gasoline and the lighter grades of fuel oil are consumed in large quantities and there is comparatively little demand for the heavier grades. It would also be suitable for the Ontario market. The domestic Pacific Coast market, on the other hand, which uses approximately the same total volume of oil as does the Prairie market consumes annually 1,500,000 bbl. of gasoline, 4,500,000 bbl. of fuel oil and 1,000,000 bbl. of bunker fuel oil. So that there are obstacles to be overcome before Turner Valley or any similar oil can displace the heavier imported oils now being refined at Vancouver for that market. A further possibility lies in supplying the British Navy with fuel oil. Britain would gladly take all the oil she could get from Alberta for this purpose, if it were suitable—unfortunately, Turner Valley oil is too light.

It is for these reasons that the recent discovery of heavier crude oil at Steveville is important. This crude, when produced in volume, would help to fuel the Navy and supply heavy fuel oil for the Vancouver market. The intense interest being taken by the larger producing companies augurs well for a rapid development of Steveville field and an early attainment of sufficient proven reserves to warrant the building of a pipeline in one direction or another.

RAIL TRANSPORT

Oil moving eastward by rail from Calgary to Prairie refineries at Moose Jaw, Regina and Brandon has been given some concessions in freight rates, but the rate from Calgary to Vancouver is around 96c per bbl. The possibility of this rate being cut to around 55c per bbl., or Vancouver oil price of $1.87 less field price at Turner Valley of $1.20 and less 12c for transporting to and loading at Calgary, appears to be rather remote. Unless subventions could be obtained from government sources to assist, rail transportation does not appear to offer a solution. Furthermore, the railways or the oil producers would have to invest $7,000,000 or $8,000,000 in new tank-cars alone to handle 20,000 bbl. or 30,000 bbl. daily across the mountains.

Freight rates to Fort William, where Alberta oil would have to be loaded on lake tankers to supply eastern Canada, presents an even more unfavourable outlook. There is no rate given on Alberta oil to Fort William, as none is shipped there, but the special rate to Winnipeg is $1.09 per bbl., and on a proportionate mileage basis the rate to Fort William would be close to $1.65. Adding tanker charges of say 10c on the Great Lakes makes total loading and carrying charges of $1.87 per bbl. Alberta oil hauled by rail to lakehead and shipped thence by tanker to Sarnia would, therefore, cost about $3.07. Illinois oil sells there for $1.75 per bbl. and sometimes less. So that railroads are out and pipelines seem to offer the best means of reaching further markets.

PIPELINES

Alberta oil producers have been discussing pipelines for over a year. A German firm proposed last summer to build one to the Pacific Coast at an estimated cost of $16,000,000, offering to accept payment in oil. In the spring of 1939, when negotiations for reduction in freight rates proved disappointing, suggestions were made to build a pipeline to Regina, perhaps to Brandon or Winnipeg, to carry the oil for Prairie markets only, but while such a line could no doubt carry oil at 75 percent or less of the existing rail rates, it would serve no useful purpose for opening up any further market in eastern Canada.

More recently attention has been given to the idea of building a pipeline as far as Regina or Winnipeg, large enough to ultimately form part of a longer line to Fort William for supplying eastern markets. Such a line would

Clearing out the hole before bringing-in a Turner Valley well.

R. C. Lane Photo

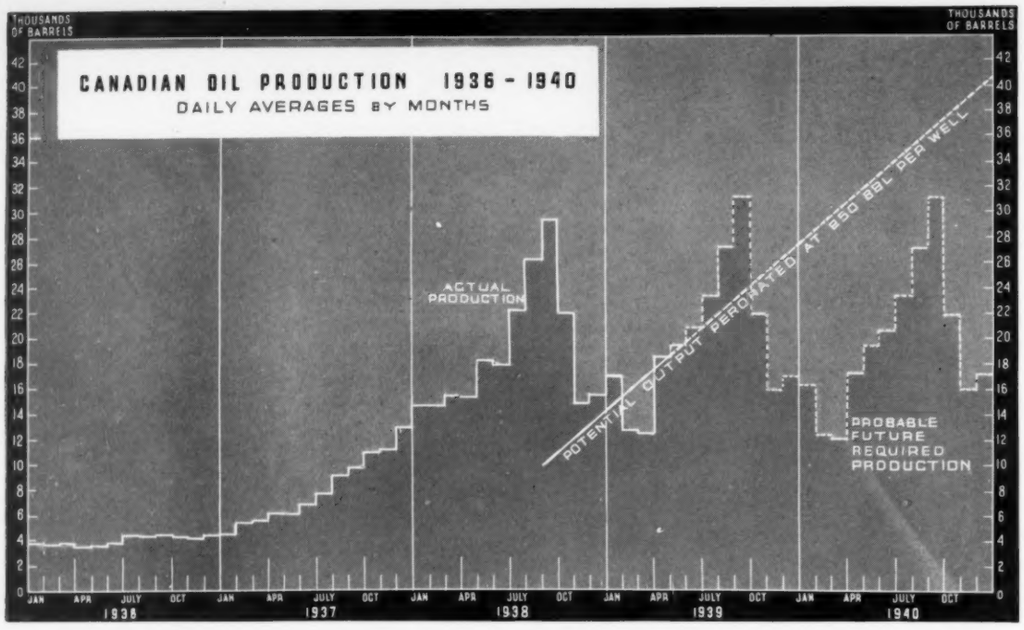
have so small a throughput at first that transportation through it would be no cheaper than rail haul. But there would be no loss, and Alberta oil would be that much nearer to an eastern market.

Such a pipeline to lakehead is a tremendous undertaking. It would be 1,200 mi. long and would cost $30,000,000. It is not likely that oil could be shipped through the Great Lakes for longer than seven months of the year, necessitating storage facilities at lakehead for storing output during the winter months, and costing another $4,000,000. Construction would be easy over the prairies, though the 400 mi. stretch east of Winnipeg would be chiefly through rocky country. It would probably require a throughput upwards of 40,000 to 45,000 bbl. daily to permit rates which would allow Alberta oil to compete with imported oil in Sarnia. This is assuming the pipeline to be of suitable size to ultimately carry 60,000 bbl. or more daily at rates around 30c to 35c per bbl. to Fort William.

The building of a pipeline over the mountains involves no unsurmountable engineering difficulties. A pipeline to the port of Vancouver, to be justified, would have to carry oil at rates which would permit competition with prices of imported oil at that point, which at the present time sells for around $1.87 per bbl. Deducting the average field price of $1.20 at Turner Valley will leave 57c for transportation. It is difficult to say what transportation will cost per barrel until the size of pipe and throughput are known. It is reasonable to believe that a pipeline large enough to ultimately carry up to, say, 40,000 bbl. daily at rates under 40c per bbl., would be able to profitably carry half this volume, or 20,000 bbl. a day, at considerably less than 57c, depending on the continuity of supply.

If there were a surplus over Prairie needs of 20,000 bbl. daily by late 1940 and if by that time there were proven oil reserves of around 300,000,000 bbl., a fair proportion of which was heavier oil from the Steveville structure, and marketing arrangements were made, such a line should be economically feasible. It would probably be located through the Crows' Nest Pass rather than along the main line of the Canadian Pacific Railroad. A route through Crows' Nest Pass is at least 80 mi. shorter and the summit is 1,100 ft. lower. Digging and covering conditions are also easier than along the C. P. R. main line.

In spite of the advantages claimed for a pipeline to the Pacific Coast, such as the much shorter distance and assurance of all-year-round navigation, there is much to be said in favor of a line to the east. There is a big market in Ontario, and no question as to the suitability of Alberta oil. If the heavier oil is found in sufficient quantity and of a suitable quality for naval requirements, there will not be a great difference in the cost of overall water transportation to European

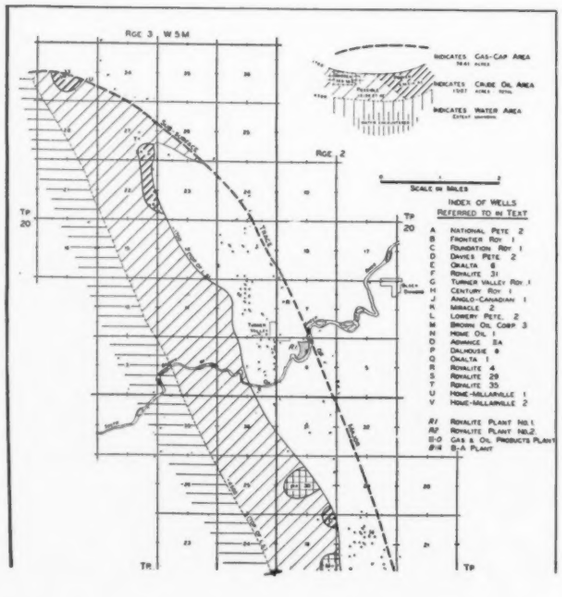


ports as between Vancouver on the one hand and Fort William via Kingston and Montreal on the other. Canada would profit by replacing the 60,000,000 bbl. of petroleum which she imports annually with oil produced in Alberta; gasoline dollars would be kept at home to stimulate domestic trade. World events, or discovery of more accessible oil supplies for Britain, can not take this market away.

Recently, Major Reginald Benson, chairman of Robert & Company, Ltd., London merchant bankers, was in Canada investigating pipeline possibilities and expressed readiness to finance the building of a line to Fort William the moment sufficient reserves are assured.

Trunk pipelines are customarily amortized over a period of 20 years. Adding the 7,000,000 bbl. annually for the Prairie provinces, to say 40,000 bbl. daily or 14,600,000 bbl. annually (probably the minimum necessary to justify the pipeline), gives 21,600,000 bbl., which for 20 years would represent a requirement of 430,000,000 bbl. of reserves.

Gas, oil and water areal map of Turner Valley (T. A. Link, 1939) from A.I.M.E.'s Petroleum Technology, August, 1939.



Just how soon this may be attained is anybody's guess, but the answer may be looked for in any or all of the dozen or so wildcat structures now being tested in many parts of the province. Once the reserves are reasonably assured, sinking of sufficient wells to give the required production will be no problem, for assurance of the building of a pipeline will give a tremendous impetus to drilling. It would only take another hundred with capacity similar to those at present producing in Turner Valley to provide the necessary additional output.

DRILLING

Cable tools were used exclusively prior to 1925, when rotary equipment was first introduced. Use of the latter increased rapidly between 1929 and 1930. Recently, rotary drilling has almost entirely displaced cable tools as standard technique. Steel 136 ft. derricks are used, usually without substructure, and steam power is employed for the heavy-duty drawworks.

Drilling times are relatively slow compared with American practice in fields of similar depths as a result of the Turner Valley Field's complicated structure and straight hole drilling problems. In recent years, drilling speed has increased and the present record is an average of over 61 ft. per day on a 7,676 ft. well, compared with slightly less than 43 ft. daily on a 6,125 ft. well in 1936. Controlled drilling and adequate supervision of the drilling mud—both native clays and commercial bentonites are used—have been important factors in improving drilling technique. Most wells show less than three percent deviation from the vertical.

In Turner Valley oil is found at depths of anywhere between 7,000 and 9,000 ft.—the deepest is 10,209 ft. and the average is 7,427 ft. There have only been two complete failures among the 80 crude wells drilled to-date. Most of the wells produced for so short a time before their flow was restricted under proration that no estimate has so far been made as to what the normal rate of depletion will be for the field. Drilling costs average between $150,000 and $160,000 per well, while time required for drilling is usually five to seven months.

ROYALTIES

The time required to return the original investment—after which further royalty payments can be treated as income—has been to-date less than two-and-a-half years in the case of about 50 percent of the Turner Valley wells, and less than 18 months for about 25 percent of them; while in a few cases the original investment has been paid back in less than a year's time. Until further markets are tapped, the returns on royalties will probably diminish somewhat as new wells come into production and share the market. But for the long-term outlook, the purchaser of an Alberta oil royalty need have no fear if his returns are thin for the time being. Since all the wells are prorated, neighboring wells are not draining the oil from his well, and ultimately the returns will be the same, assuming the prices remain the same—only spread over a longer period.

Most of the earlier drilling programs were financed in much the same way as many Canadian mines, not always without the evils of manipulation or share-pushing. Often income from sales of naphtha was used for drilling wildcat wells instead of for paying dividends. But since the discovery of crude oil, the customary method of financing has been with royalties, as has been so successfully used in the California, Texas and Oklahoma fields and under which there is assurance of the investor getting a definite share of production when his well blows in.

Canadian oil royalties are subject to a 25 percent exemption for income tax. All funds are handled by recognized trust companies, who receive all monies from royalty purchasers, pay the drilling contractor, and when the production commences they pay out the proceeds of production, less expenses, to all royalty-holders. In event of the purchase by some other company in the future of the majority of the royalties, the holder of any one royalty certificate cannot be eliminated, for in that event, under the trust agreement the well must be continued in operation. A further safeguard is the audit by the provincial government to ensure their obtaining the 10 percent gross royalty returns to which they are entitled. In the case of freehold leases such as Calgary and Edmonton lands, this 10 percent is not payable to the province, but 15 percent goes to the Calgary and Edmonton Company instead.

Alberta oil development is now attracting investors from many parts. Standard of California, and Benedum & Trees, well-known oil promoters from Pittsburgh, are interested in the British Columbia and Alberta portions respectively of the Pouce Coupe field northwest of Edmonton, oil from which may some day be piped 425 mi. west to tidewater at Bellacoola. In spite of Rocky Mountain ranges, short navigation seasons on the Great Lakes, boundary lines, tremendous distances, there is a growing belief that Alberta has a great future.

Possible Missouri Production May Further COMPLICATE CRUDE MARKETS

By Gilbert W. Noble

To-Date the Nation's Lar gest Oil-less Oil Boom — Tomorrow Discovery of Petroleum in North-west of State May Displace Crude From Kansas or Oklahoma — Rigid Proration Unlikely.

FOR OVER A YEAR northern Missouri has been on the verge of a genuine oil boom. Estimates of total area under lease range from 500,000 to 1,500,000 acres. The most unusual feature of the activity, however, is that no wildcat well drilled in the last half-dozen years has focussed interest on the area.

The boom can hardly be explained as being due solely to wishful thinking on the part of Missourians or the oil fraternity. Neither can it be attributed to the follow the leader principle which makes so many operators willing to sink their resources into any oil venture that a competitor thinks good enough to warrant expenditure of his own money. Unquestionably, both of these factors have operated to enlarge the magnitude of the boom, but they do not of themselves explain the origin of, or real basis for, the lease play. Four more important factors are the similarity of geological conditions to those in the Illinois basin; the strategic location of northern Missouri, which is not only near many trunk pipelines carrying crude oil to the Chicago refining center, but is also located in an area with substantial and growing demand for refined products now supplied from the Mid-Continent and Chicago areas; proration in the Mid-Continent states; and a better realization on the part of producers of the economies possible through recent developments in slim hole drilling.

Strict silence is maintained as to precisely which companies are active in the Missouri lease play, and even the best oilfield scouts do not seem to have a complete list. As there is no state legislation requiring the leases to be filed immediately, such registration may not take place for a year or more after negotiations for exploration rights have been completed.

Among the concerns understood to be actively leasing are Skelly, Stanolind, Tide Water, Magnolia, Ohio, Pure and Sinclair-Prairie, but this partial list may possibly omit some of the most important concerns. Most of the drilling in progress is by smaller independents, and only minor oil shows have been encountered.

Similarity to Illinois

The Illinois basin lies between the LaSalle anticline and the Ozark land mass; in northwest Missouri the Forest City basin occupies a symmetrical position between the Nemaha uplift and the Ozark land mass. The two basins are separated by the Nemo arch in northeastern Missouri. The strong similarity between these two branches of what may be considered one geological province has been known to geologists for years. As more new pools have been discovered in the Illinois basin, oil men have given more serious consideration to the likelihood of discovering commercial oil pools in the Forest City basin as well.

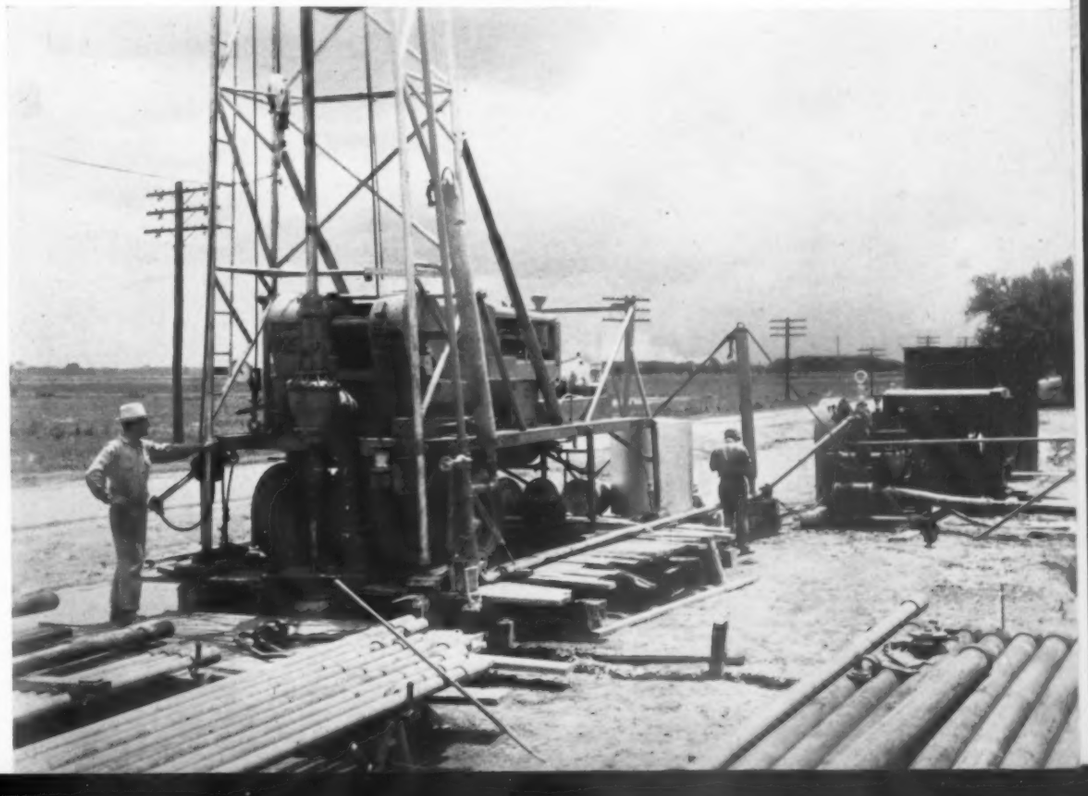
The generalized geological section across northern Missouri shows the thickening of the Pennsylvanian formations in the Forest City basin area. Of possibly far greater importance may be the numerous uncomformities which on the one hand assist in connecting source beds with reservoir beds and on the other hand may well serve as stratigraphic traps for commercial oil pools. Within the past six months the Missouri State Geological Survey has published a map showing the results of a magnetometer survey of the Missouri portion of the Forest City basin area. Torsion balance and seismograph crews have done detail work on some areas and a number of the major companies still have crews in the area. Small amounts of oil and gas have been produced within the Forest City basin area for many years. All of this production has been from shallow sands and black shales of Pennsylvanian age. The Missouri Geological Survey bulletin on the area lists 158 holes drilled in the area; but points out that 68 percent of these never penetrated basal Pennsylvanian formations and only six percent reached Ordovician formations. Since it is believed that less than half-a-dozen of the 158 wells drilled were located favorably with respect to geologic structure, drilling to-date has not properly tested the oil possibilities of the area.

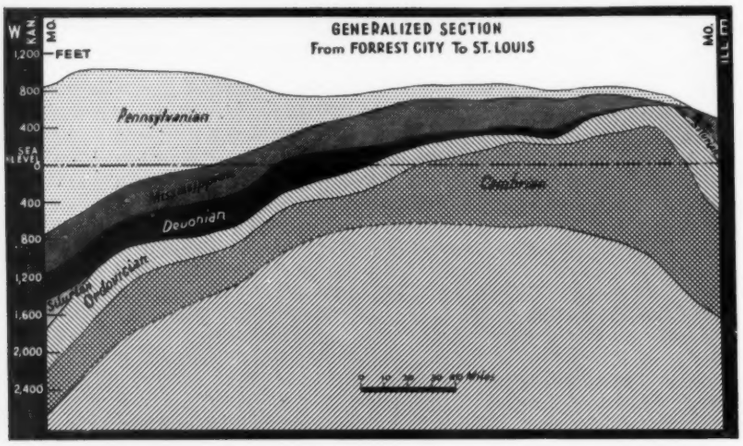
Strategic Location

The oil industry today must not only find and produce a supply of crude petroleum adequate to meet the demand for the two chief refined products, gasoline and fuel oil, but must also transport these refined products to the consumer. The chief supplies of crude petroleum are in the Mid-Continent and Gulf coast fields and the chief markets are in the North Central and North Atlantic industrial centers. It has been found advantageous to locate the refineries near consuming centers and ship the crude petroleum to the refineries.

The accompanying pipeline map shows the trunk oil lines feeding the refineries in the Wood River and the Chicago refining centers. If oil can be found in northern Missouri it could be delivered to the Chicago or Wood River areas at a transportation cost of about one-half that charged against oil now moving to these centers from Oklahoma or Kansas fields or at a transportation cost of slightly over one-third of that for oil now moving from Texas fields.

Drilling costs in Missouri will be low as they are in Illinois where this highway trailer unit is being used for slim hole drilling near Sandoval.





Below—derrick man riding elevators to fourble board; right—taking a Schlumberger test on an Illinois wildcat; extreme right—map of Missouri showing the possible petroliferous areas and the relation of the state to existing transport systems and consuming centers; heavy lines indicate gasoline pipelines and light ones represent crude oil systems.

Market Demand

Market demand for refined products presents a two-fold problem: first, the magnitude of the demand in the Chicago or central refining area which is now being satisfied largely by crude oil shipped through Missouri from Kansas, Oklahoma, and Texas; second, the possibility of establishment of a new marketing area centering around northern Missouri.

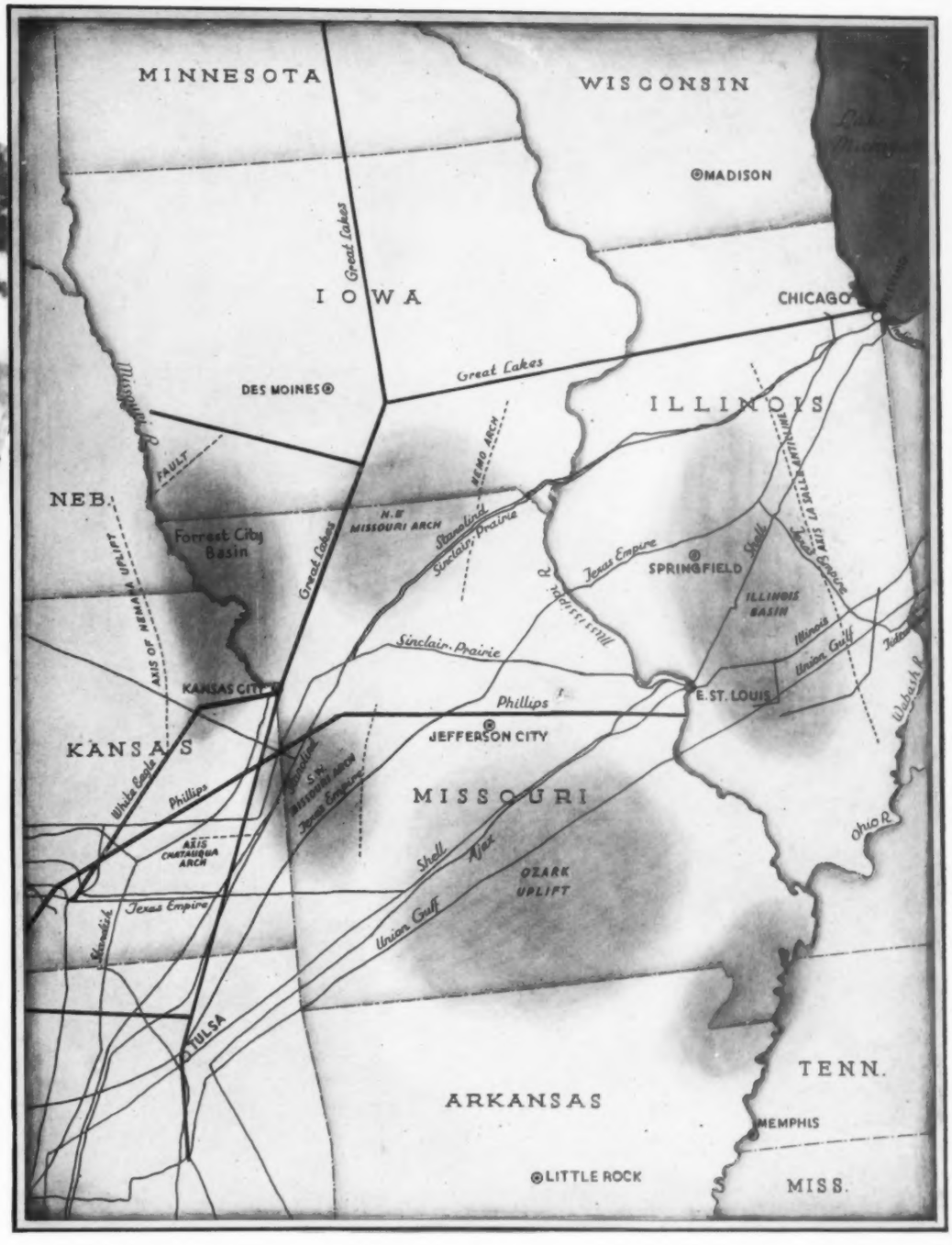
TABLE I

Indicated Crude Oil Supply and Demand in the Central or Chicago Area (a)

	Gasoline Consumption (Thous. Gal.)	Indicated Crude Oil Demand (b) (Thous. Bbl.)	Crude Oil Production in Area (Thous. Bbl.)	Indicated Deficiency at Crude Oil Supply (Thous. Bbl.)
1930	3,340,551	139,000	21,273	118,000
1931	3,474,998	159,000	18,787	140,000
1932	3,178,192	145,500	20,998	124,500
1933	3,147,394	145,500	19,648	126,000
1934	3,356,154	155,500	22,897	132,500
1935	3,617,355	165,500	28,174	137,500
1936	4,065,924	186,000	24,623	161,500
1937	4,485,105	205,500	27,607	178,000
1938	4,455,202	204,000	44,362	159,500

(a) Includes Wisconsin, Michigan, Illinois, Indiana, Kentucky and the western half of Ohio.
(b) Using an average gasoline yield of 52 percent.

The location of the Chicago refining center should theoretically give it a marketing area covering Wisconsin, Michigan, Illinois, Indiana, Kentucky and the western half of Ohio. The proposed new Missouri marketing area might be expected to cover Missouri, Iowa, and Minnesota. From Tables I and II it can be seen that the present annual gasoline de-



mand in the Chicago area thus designated is approximately 107,000,000 bbl. and in the Missouri area about 36,000,000 bbl. Using the 1935 to 1937 average gasoline yield (by combined straight run and cracking) of 52 percent, these figures may be translated into equivalent yearly crude oil demands of about 200,000,000 bbl. for the Chicago area and 75,000,000 bbl. for Missouri area.

TABLE II

Indicated Crude Oil Demand of the Missouri Area (a)

	Gasoline Consumption (Thous. Gal.)	Indicated Crude Oil Demand (b) (Thous. Bbl.)
1930	1,256,294	57,500
1931	1,346,910	61,500
1932	1,216,198	55,500
1933	1,223,167	56,000
1934	1,324,749	60,500
1935	1,375,756	63,000
1936	1,508,683	69,000
1937	1,596,290	73,000
1938	1,666,376	76,500

(a) Includes Missouri, Iowa and Minnesota.
(b) Using an average gasoline yield of 52 percent.

In spite of development of the Illinois basin pools the crude oil produced in the Chicago area will now supply only about one-sixth of the demand for gasoline in this territory. The present crude production of the Missouri area is the utterly insignificant amount produced from the shallow stripper wells near Kansas City.

The 160,000,000 bbl. deficiency of crude production in the Chicago area is met in large part by shipping crude from Oklahoma, Kansas and Texas to Wood River and Chicago refineries through the trunk pipelines shown on the accompanying map; the balance of the deficiency being met by movement of gasoline through the two gasoline pipelines shown and by shipments of gasoline from the Mid-Continent area by tank car and tank trunks.

The 75,000,000 bbl. apparent crude demand in the Missouri area is being met entirely by shipments of gasoline by pipeline, tank car, and truck—in large part from Oklahoma and Kansas, but to some extent from Wood River and Chicago refineries. At this time the lone refinery operating in Missouri has a daily capacity of slightly over 20,000 bbl. of crude oil, hence the development of a separate Missouri marketing area awaits the construction of a large amount of refinery capacity. This would entail curtailed runs to refineries chiefly in Oklahoma and Missouri. Whether or not refiners will consider it expedient to construct new refineries to supply the demand of this area is problematic. In any event, there is assured an abundant demand for crude oil relatively close to Missouri.

Globe Photo

Should oil be discovered in quantity in Missouri it seems likely that the state legislature will adopt the same attitude toward proration as that of Illinois—above, an Illinois field at Oak Grove Cemetery and top, a temporary pipeline station in the Louden field near St. Elmo, Illinois.

Effect of Proration

One of the chief drawbacks to proration in practice is that it attempts to correct serious overproduction after it occurs. Proration may be the lesser of alternative evils to producers of Texas, Oklahoma, and Kansas, but it should be remembered that even under proration each of these states produces enough crude to supply its own demand and export large quantities to other states. To-date the Illinois legislature fails to see why Illinois wells should be curtailed to allow more crude to be shipped in from other states. Oil in quantity has not yet been discovered in Missouri and naturally no one can predict in advance the course that will be taken by the Missouri legislature, but it seems reasonable to suppose that their point of view will be similar to that of the Illinois body. Some operators have invested in Missouri leases on the expectation that there is slight chance of rigid proration until the state has developed a supply of oil in excess of its demand.

Slim Hole Drilling

So far as is known at present, no sedimentary deposits lie deeper than 5,000 ft. in the Forest City basin. Thus all drilling in this area is within reach of slim hole drilling equipment now being used in Kansas and Illinois. The savings made possible by slim hole drilling were pointed out in WORLD PETROLEUM, June, 1939. In Kansas, development costs have already been reduced from around $30,000 to $15,000 or $16,000 by slim hole drilling and the cost trend continues downward. This huge reduction in oil finding and development cost will greatly encourage thorough testing of the Forest City basin.

Present knowledge of geology is encouraging, a large market for crude oil lies close at hand, threat of rigid proration in event of discovery does not seem great, and facilities to cheaply test the area and develop it if oil is discovered are already available. Drilling materials have been moved in, and within the next 12 months we shall know whether Missouri enters the ranks of oil-producing states or whether the nation's great oilless oil boom was merely an empty bubble.

U. S. SHIPMENTS DECLINE
in First Half of 1939

More Crude Purchased Abroad as Exports Fall Off—Mexican Petroleum Imported for Houston Refining — Japan Buys Less Crude as Cash is Demanded, But Reduced Export Prices Stimulate Purchases of Fuel Oil.

TOTAL EXPORTS of American petroleum and products during the first half of the year declined by $19,342,000 to $170,212,000 from the corresponding period of 1938. Only lubricating oils and residual fuel oil showed an increase, by $1,774,000 and $265,000, respectively, while $3,830,000, $2,237,000 and $1,357,000 were the respective reductions in value of gasoline, kerosene, and gas oil shipments. Crude oil was the chief cause of the falling off in total export value, being responsible for a drop of $13,958,000.

Imports of crude from abroad, however, showed an increase—almost as great as the decline in exports — and helped to swell domestic stocks.

Exports of unrefined petroleum during the first six months of 1939 fell to 34,949,000 bbl. from 40,176,000 bbl., a decline of 13 percent. Greatest reduction was in shipments to the Orient, as insistence on cash for oil on tanker tended to curtail Japanese liftings, which dropped to 7,844,000 bbl. from 13,691,000 bbl. This seems in some measure to have been made up for by increased purchases of fuel oil by that country, rising to 2,351,000 bbl. from 1,337,000 bbl., and suggests either increased cracking activities or larger additions to naval fuel reserves.

Surprising in view of the increased production activities in the Turner Valley area, reported on page 31 of this issue, Canada provided an outlet for an additional 523,000 bbl. of crude over last year's requirements, the figures rising to 11,418,000 bbl. from 10,895,000 bbl. Presumably, this must have been destined for Eastern Canada where American crude oil meets little domestic competition. France reduced her imports from

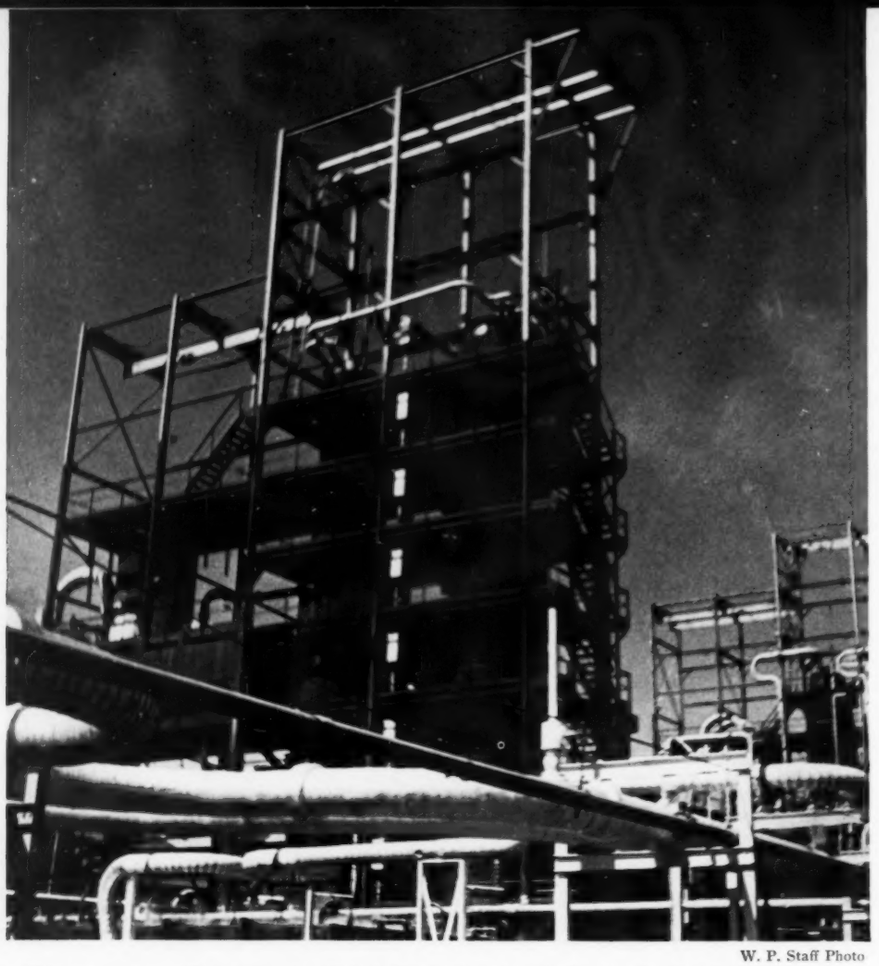
CHANGES IN U. S. OIL EXPORTS
(In Thousands of Units)

EXPORT	JAN.-JUNE 1939	JAN.-JUNE 1938	PERCENT CHANGE
	(Barrels)		
Crude oil	34,390	40,176	−13
Motor fuel	22,121*	22,569	−2
Kerosene	3,596	3,913	−8
Gas oil and distillate	15,392	14,725	+5
Residual fuel oil	8,055	6,938	+16
Fuel oil bunkers	18,589	18,765	−1
Lubricating oil	5,215	4,903	+6
	(Pounds)		
Greases	47,871	35,640	+34
Liquid gases	7,496	1,904	+294
Paraffin wax	124,912	87,937	+42
	(Long Tons)		
Asphalt	107	102	+5
Refinery coke	105	49	+114

*Includes 2,493,000 bbl. of aviation gasoline, classification initiated January 1st, 1939.

U. S. OIL EXPORTS JAN.-JUNE, 1938 AND 1939
(In Thousands of Barrels)

DESTINATION	CRUDE OIL		GASOLINE		KEROSENE		GAS AND FUEL OIL		RESIDUAL FUEL OIL		LUBRICATING OIL	
	1939	1938	1939	1938	1939	1938	1939	1938	1939	1938	1939	1938
Argentina	1,240	790	.....	25	.....	.....	.....	.....	.....	.....	8	16
Australia	.....	.....	407	1,026	32	128	16	9	.....	9	242	222
Belgium	116	228	600	640	7	41	521	559	58	14	387	438
Brazil	84	1	599	831	191	246	119	221	.....	.....	120	128
Canada	11,418	10,895	1,247	1,425	86	76	208	234	243	458	219	239
Chile	18	1	198	95	9	28	106	41	800	1,144	30	26
China	89	166	65	.....	119	19	238	181	91	.....	55	37
Cuba	601	533	309	399	1	....	.....	117	186	686	21	18
Denmark	156	.....	266	291	230	260	212	386	152	61	110	86
Finland	.....	.....	9	120	26	32	53	6	.....	.....	9	10
France	8,253	8,083	1,955	1,986	.....	6	57	81	.....	89	211	276
Germany	416	729	344	584	17	1	2,574	2,224	.....	.....	699	619
Guatemala	.....	.....	37	32	8	4	5	3	115	174	4	4
Haiti	.....	.....	114	10	9	9	2	.....	.....	.....	.....	.....
Hong Kong	.....	.....	121	75	55	107	159	74	91	59	7	24
Italy	2,900	3,324	224	254	13	.....	25	.....	878	204	160	143
Japan	7,844	13,691	627	677	20	1	2,957	2,482	2,351	1,014	202	133
Kwantung	78	255	317	195	212	84	39	.....	.....	.....	22	24
Mexico	41	41	130	117	12	12	53	256	151	499	47	32
Morocco	.....	.....	.....	.....	10	.....	.....	6	.....	184	6	4
Netherlands	192	190	850	1,159	507	348	1,664	1,179	386	306	135	63
Netherland West Indies	.....	.....	2,827	2,195	220	611	1,340	3,040	.....	.....	10	4
New Zealand	.....	.....	284	533	16	52	.....	53	89	72	32	37
Norway	15	.....	75	185	82	49	163	183	61	.....	18	15
Other French Africa	.....	.....	54	37	19	28	11	9	.....	75	8	9
Other Spanish Africa	.....	.....	.....	.....	.....	.....	84	109	312	274	.....	1
Panama Canal Zone	.....	50	97	111	18	19	402	472	358	325	3	1
Philippines	.....	.....	624	528	262	284	234	327	388	355	50	41
Portugal	.....	.....	364	95	122	52	92	3	.....	95	27	17
Spain	.....	54	859	1,091	.....	12	312	124	385	253	77	51
Sweden	489	615	1,053	1,130	156	222	415	196	189	139	101	87
Switzerland	.....	281	545	6	25	....	108	.....	.....	.....	1	.....
Turkey	.....	.....	181	127	79	68	58	.....	.....	.....	19	16
U. S. S. R.	.....	.....	.....	644	.....	.....	.....	.....	.....	.....	.....	.....
Union of South Africa	.....	45	136	391	.....	8	6	74	.....	.....	66	62
United Kingdom	275	55	5,480	4,410	685	836	2,781	1,794	199	160	1,557	1,445
All others	724	146	858	1,036	348	270	378	282	572	289	532	575
Total Volume	34,949	40,176	21,876	22,460	3,596	3,913	15,392	14,725	8,055	6,938	5,215	4,903
Value (000's)	$45,198	$59,156	$52,693	$56,593	$6,958	$9,195	$21,603	$22,960	$6,362	$6,097	$37,398	$35,624



W. P. Staff Photo

Shipments of gasoline from the United States showed a decline in the first half of 1939 — Cracking coil, Bayway refinery of Standard Oil Company of New Jersey.

Iraq during the period under discussion and increased her purchases of American oil by 170,000 bbl. to 8,253,000 bbl. Italy's barter agreements with Mexico and controlled supply from Albania showed an effect upon her dealing with the United States as her purchases of 2,900,000 bbl. American crude oil were less by 424,000 bbl. than last year.

Aviation-gasoline exports were not segregated before January 1st, 1939. In the first six months of this year they amounted to 2,493,000 bbl., or 11.4 per cent of all gasoline exported.

Exports of ordinary gasoline dropped slightly, from 22,460,000 to 21,876,000 bbl. Shipments to the U. S. S. R., which fell from 644,000 bbl. to nothing, more than accounted for the decline. Although Japan decreased its purchases by 50,000 bbl., larger shipments (317,000 bbl., as against 195,000 bbl. in 1938) went to Japanese-controlled Kwantung. Rationing of gasoline and regulations compelling use of alcohol with gasoline have reduced civilian motor fuel requirements in the Island Empire.

Exports of gas and distillate fuel oils increased by 667,000 bbl. to reach a figure of 15,392,000 bbl. Purchases of 1,794,000 bbl. and 2,482,000 bbl. in 1938 by the United Kingdom and Japan were higher by 987,000 bbl. and 475,000 bbl., respectively, while exports to Netherland West Indies of 1,340,000 bbl. were less than half the quantity taken last year.

Shipments of residual fuel oil increased to 8,055,000 bbl. from 6,938,000 bbl. Largest gain was registered by Japan.

Lubricating oil sales abroad reached 5,215,000 bbl., an increase of 312,000 bbl. The United Kingdom, Germany, Netherlands, and Japan with purchases of 1,557,000 bbl., 699,000 bbl., 135,000 bbl. and 202,000 bbl., registered respective gains of 112,000 bbl., 80,000 bbl., 72,000 bbl., and 69,000 bbl., while Belgium and France with purchases of 387,000 bbl. and 211,000 bbl. took less by 51,000 bbl. and 65,000 bbl.

Imports of crude petroleum and principal refined oils into the United States during the first six months of 1939 amounted to 30,097,000 bbl., an increase of nearly 15 percent over the corresponding period of last year. Larger purchases of overseas crude were chiefly responsible for the gain.

Crude imports increased to 16,288,000 bbl., a gain of 3,844,000 bbl. Entries for immediate consumption were higher by 2,418,000 bbl., due to heavier shipments from Venezuela and Colombia, while imports from Mexico for refining in bond at Houston increased from nothing to 1,406,000 bbl.

Gasoline imports were negligible, aside from an entry in March of 313,000 bbl., from Mexico into bond at New Orleans. Receipts of naphtha (not motor fuel) and finished light products, though small, rose from nothing to 20,000 bbl. Although there was little change in receipts of gas oil and distillate fuel oil for immediate consumption, entries from Netherland West Indies for refining in bond at New Orleans increased from nothing to 407,000 bbl. New classifications for fuel oil, topped crude, and unfinished distillates preclude comparisons with the first six months of 1938.

Of the remaining petroleum products imported for immediate consumption, receipts of lubricating oils, always unimportant, were smaller; paraffin wax imports fell from 18,537,000 bbl. to 15,756,000 bbl.; natural asphalt and bitumen, however, increased from 9,360 to 46,504 long tons. It is probable that of the latter figure, the 26,490 tons shown as originating in Netherland West Indies was actually petroleum asphalt.

The accompanying statistics are according to the Metals and Minerals Division, U. S. Department of Commerce.

U. S. OIL IMPORTS JAN.-JUNE, 1938 AND 1939

(In Thousands of Barrels)

	Entered for immediate consumption		Withdrawals from bond for consumption		Withdrawals from bond for supplies to vessels		Withdrawals from bond for re-export		Entered bonded warehouse		Entered bonded manufacturing warehouse for manufacture and re-export	
	1939	1938	1939	1938	1939	1938	1939	1938	1939	1938	1939	1938
Crude oil	13,363.9	10,945.8	3.9	.....	.....	.....	.....	.....	.....	15.0	2,909.6	1,198.0
Gasoline	‡	3	.....	.....	.....	.....	.....	44.1	313.5	.....	.....	.....
Naphtha, etc	19.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gas and Diesel oil	126.7	106.3	3.0	3.3	.....	.....	.....	.....	.....	.....	407.0	.....
*Fuel oil incl. topped crude	.....	2,828.2	.....	427.1	.....	9,287.6	.....	.....	.....	9,526.8	.....	.....
†Residual fuel oil	959	.....	229.7	.....	8,185	.....	.....	.....	8,542	.....	.....	.....
*Unfinished distillates	.....	18.5	.....	.....	.....	.....	.....	.....	.....	189.9	.....	1,090.8
†Unfinished oils including topped crude	2,562.4	.....	‡	.....	.....	.....	.....	.....	‡	.....	873.3	.....
Lubricating oils	2.3	3.8	‡	‡	2.2	2.2	.....	.....	2.2	2.5	.....	.....

* 1938 classification.
† 1939 classification.
‡ Less than 1,000 bbl.

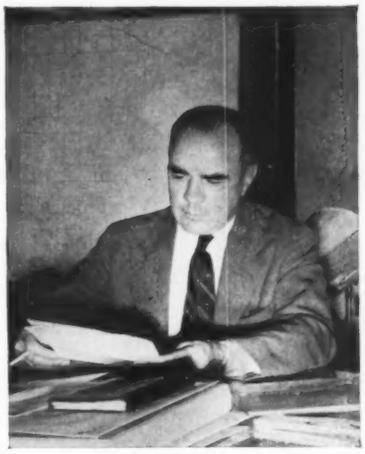
Foreign Oil Legion

George Johnston

GEORGE JOHNSTON, marine superintendent for Lago Petroleum Corporation and Standard Oil Company of New Jersey subsidiaries in the lake basin of Venezuela, left Maracaibo during the first week of August. He is accompanied on his vacation by Mrs. Johnston, and they will spend several months in Europe as well as the United States. Mr. Johnston is one of the prominent members of Maracaibo's Foreign Colony and is well-known in Venezuelan oil circles, having been stationed there for the past 13 years. Not only is he an excellent golfer with a low handicap at the Maracaibo Country Club, but he is also one of the most able skippers in the fleet of Star Class sailing boats, and his prowess as a yachtsman has brought him many valuable prizes and keeps his rivals awake nights. Mr. Johnston's father was one of the original oil men in Mexico with Huasteca Petroleum Company during the boom days.

LT. COMMANDER W.H. OSGOOD, U.S. Navy Ret., was recently recalled to active duty for special work as Inspector of Naval Petroleum Reserves in California. He will relieve CAPT. WILLIAM G. GREENMAN, U. S. N., who is returning to sea duty as Commander of Destroyer Squadron Ten, U. S. Fleet. Lt. Commander Osgood is well known in the petroleum industry, and is well qualified both by experience and training for his new duties. Following his graduation from the Naval Academy at Annapolis, and considerable sea service, he took Naval post-graduate work at Columbia University, receiving his M. Sc., and at University of Pittsburgh, where he received his degree of Petroleum Engineer. He served for some time as Inspector of Naval Petroleum and Oil Shale Reserves in Wyoming, Colorado and Utah, and was instrumental in developing and starting a course in laboratory research for the Navy Department on the subject of fuel oil for the Navy. He retired from active service in 1932.

After a period spent as engineer in the office of the California Oil Umpire, Commander Osgood entered private practice as a consultant, specializing in production engineering problems and offering a service to the California oil industry in the measurement of sub-surface pressure. Among his well-known technical publications is a two-volume work entitled "Increasing the Recovery of Petroleum" and numerous papers on the subject of sub-surface pressures.



Lt. Commander Osgood

ERNEST H. SMITH, drilling superintendent for Bahrein Petroleum Company Ltd. at Awali, arrived in New York on board the CONTE DE SAVOIA and after a few days stay left for his home in Fullerton, California, early in August. With him on this trip were Mrs. Smith and their children. While they were younger the children were taught at an American school in India, but now that one of them is of high school age they will remain in California for further education when Mr. Smith returns to Bahrein in a few months time.

SAMUEL V. GUERIN, Texas petroleum producer, is staying at the Hotel Grand while in Paris, having just returned from a trip to Moscow, Danzig, Berlin, Prague, Budapest and Vienna.

CHAS. E. DAVIS, assistant manager in charge of producing operations at the Awali oilfield of Bahrein Petroleum Company Ltd. is due to pass through New York about the middle of September en route to Europe and Bahrein, after the completion of his vacation at Mudania, California.

A. H. CHAPMAN, who has charge of all drilling activities in Britain for Anglo-American Oil Company, returned to England on the NIEUW AMSTERDAM after a short visit to the United States. Since discovery of oil in Scotland by the company's first wildcat in that country, Mr. Chapman has made his headquarters in Edinburgh.

RT. HON. LORD GREENWAY, formerly on the board of Anglo-Iranian Oil Company Ltd. and subsidiaries, will arrive in New York September 29th from Montreal, Canada, having made the Atlantic crossing from England on the MONTROSE.

HARRY F. ABRAMS, member of Socony-Vacuum manufacturing committee in charge of overseas refining, retired recently after 36 years association with the Vacuum interests.

AXEL GRONBECK, European representative of The Lummus Company with headquarters at London, arrived in New York in the middle of August on one of his periodic business trips to the United States. He is visiting St. Louis, Pittsburgh and other important cities, but will spend most of his time in New York. Refinery construction by Lummus in European and Far Eastern countries is steadily increasing and several large orders have been received, including a big plant for production of high-octane aviation gasoline in France.

J. H. HUTTON has been appointed general manager of Redline-Glico Ltd., petroleum marketing company affiliated with the Jersey Standard group in England. He succeeds THOMAS HORNBY, who has retired. Before joining Redline-Glico last June, Mr. Hutton was general sales manager of Anglo-American Oil Company Ltd.

J. H. Hutton

WORLD OIL

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified

U. S. BARRELS

	Aug. 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	June 1939	Preliminary Figures July 1939
United States	106,165,000	98,661,000	101,830,000	98,567,000	102,287,000	102,490,000	93,475,000	106,768,000	105,510,000	110,541,000	104,607,000	109,913,600
Soviet Union[4]	17,600,000	17,500,000	17,400,000	17,250,000	17,050,000	17,000,000	17,500,000	18,000,000	18,100,000	18,500,000	18,700,000	18,200,000
Venezuela	16,616,673	16,271,096	17,352,171	16,356,204	16,744,163	16,489,347	14,899,459	15,646,415	16,980,646	17,676,580	16,430,693	17,000,000
Iran[5]	5,861,366	5,676,998	7,136,578	7,221,080	6,624,726	6,408,776	4,982,000	6,999,058	7,244,370	6,801,192	6,900,000[1]	7,000,000
Netherland India: Sumatra	2,901,321	2,917,167	3,049,196	3,015,432	3,177,589	3,129,007	2,969,950	3,393,286	3,400,503	3,602,543	3,498,094	3,600,000
Borneo	970,690	1,069,872	1,123,102	1,090,009	1,114,535	1,115,570	1,000,937	1,134,647	1,123,474	1,173,509	1,154,341	1,172,000
Java[9]	524,384	482,417	523,623	515,160	529,658	535,297	503,441	550,097	509,355	530,273	514,565	535,000
Ceram	54,825	50,355	50,444	45,750	45,773	49,200	55,219	67,442	82,914	89,975	77,305	80,000
Roumania	4,075,736	3,915,029	4,028,750	3,847,324	3,969,300	3,934,338	3,638,020	3,973,053	3,759,111	3,839,580	3,684,366	3,760,000
Mexico[13]	3,247,904	3,416,583	3,313,182	3,098,725	3,245,558	2,470,000[1]	1,960,000[1]	3,118,021	3,140,120	2,945,000[1]	3,100,000[1]	3,245,000
Iraq	2,829,528	2,621,547	2,431,949	2,420,143	2,290,777	2,414,878	1,955,122	2,699,272	2,608,216	2,663,827	2,721,992	2,731,000
Colombia	1,870,013	1,797,158	1,891,825	1,863,838	1,908,879	1,710,565	1,633,621	1,818,765	1,826,928	1,899,735	1,851,716	1,900,000
Trinidad	1,505,959	1,514,893	1,594,480	1,503,489	1,664,322	1,652,412	1,499,197	1,630,789	1,569,298	1,645,040	1,575,321	1,640,000
Argentina[1]	1,360,000	1,358,000	1,360,000	1,358,000	2,028,000	1,534,000	1,430,000	1,556,000	1,549,000	1,556,000	1,530,000[1]	1,556,000
Peru[3]	1,328,143	1,280,691	1,331,111	1,303,990	1,321,883	1,251,162	1,103,878	1,210,288	1,151,193	1,078,426	1,051,265	1,100,000
Bahrein[6]	713,149	714,349	708,962	613,281	623,907	647,988	610,766	658,822	629,336	626,009	650,000	657,000
Burma[7]	637,880	623,630	604,885	591,029	651,495	698,103	424,277	600,863	635,000[1]	640,000[1]	635,000[1]	640,000
Canada[2]	817,706	886,111	685,088	445,514	489,303	531,564	356,218	384,461	558,779	713,450	700,000[1]	723,500
Brunei[8]	448,219	478,080	477,459	484,207	510,500	506,467	453,571	492,374	466,328	486,815	465,000[1]	486,800
Great Germany: Old Reich[14]	342,484	328,098	331,792	307,433	313,206	332,592	330,584	395,181	373,126	409,782	373,510	410,000
Ostmark[15]	29,453	26,772	43,697	29,000[1]	34,259	33,609	46,666	43,293	54,375	64,840	78,944	81,000
Slovakia and Moravia	11,015	10,933	13,747	10,502	9,879	10,546	9,000[1]	10,000[1]	9,000[1]	10,000[1]	9,000[1]	11,000
Poland	328,115	321,134	330,412[1]	318,000[1]	316,702	325,293	298,259	333,618	326,400[1]	333,800[1]	318,000[1]	330,000
Japan[16]	217,525	170,597	220,451	224,255	173,737	224,885	218,594	222,368	218,594	221,229	221,500	222,400
British India[11]	225,897	217,058	210,348	197,809	217,528	253,874	213,185	236,042	215,000[1]	230,000[1]	215,000[1]	230,000
Ecuador	193,634	189,037	192,702	185,669	192,882	195,556	171,634	181,938	175,896	193,753	113,710	206,868
Saudi Arabia	3,459	40,556	136,947	152,632	139,038	155,605	170,865	215,270	234,742	281,325	392,932	342,558
Sarawak[12]	107,102	123,476	223,165	115,952	118,512	116,030	105,714	115,980	110,982	112,572	101,000[1]	112,600
Egypt[13]	143,978	157,533	208,377	211,841	221,156	308,946	301,102	330,445	328,376	369,972	356,000[1]	370,000
Italian Empire: Albania[16]	4,998	68,655	Nil	Nil	6,220	99,206	67,914	125,440	244,576	81,839	83,000[1]	89,000
Italy	9,057	8,267	8,622	8,533	7,937	7,511	8,090	8,324	7,797	7,253	7,700[1]	7,600
France	43,000[1]	41,104	42,296	40,797	48,000[1]	42,000[1]	40,000[1]	42,000[1]	41,000[1]	42,000[1]	41,000[1]	42,000
Hungary	30,900[1]	38,240	49,800[1]	43,303	47,671	49,199	49,578	67,261	67,000[1]	70,000[1]	67,000[1]	70,000
Bolivia[1]	9,200	8,500	8,800	8,500	9,000	8,800	7,000	8,700	8,500	8,700	8,500	8,700
Other Countries[17]	6,000	50,000	48,000	50,000	48,000	50,000	35,000	50,000	48,000	50,000	48,000	50,700
WORLD TOTAL	171,234,333	163,034,936	168,952,001	163,494,401	168,191,035	166,782,326	152,523,861	173,087,513	173,307,935	179,496,019	172,281,454	178,524,326

[1] Estimated.
[2] Includes natural gasoline (naphtha) production.
[3] International Petroleum Company and Lobitos Oilfields, Ltd., figures combined.
[4] Russian Saghalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company, Ltd., figures revised —fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company, Ltd., figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company, Ltd., figures.
[9] Includes Madura.

Comparative Cumulative Daily Averages in Barrels

	Jan.-July 1939	Jan.-July 1938
United States	3,458,984	3,329,123
Soviet Union	594,340	563,169
Venezuela	543,034	495,654
Iran	218,563	216,052
Netherland India: Sumatra	111,289	92,756
Borneo	37,144	35,114
Java	17,349	20,697
Ceram	2,368	1,703
Roumania	125,417	134,064
Mexico	94,236	104,641
Iraq	83,935	85,660
Colombia	59,629	57,782
Trinidad	52,886	46,901
Argentina	50,524	44,684
Peru	37,482	39,361
Bahrein	21,132	23,704
Burma	20,157	20,680
Canada	18,717	17,041
Brunei	15,837	14,098
Great Germany: Old Reich	12,381	10,505
Ostmark	1,900	976
Slovakia and Moravia	323	353
Poland	10,686	10,420
Japan	7,309	6,154
British India	7,515	6,395
Ecuador	5,846	6,148
Saudi Arabia	8,459	106
Sarawak	3,655	4,408
Egypt	11,155	2,916
Italian Empire: Albania	3,731	1,536
Italy	256	300
France	1,368	1,434
Hungary	2,076	587
Bolivia	278	299
Other Countries	1,565	193
WORLD TOTAL	5,641,526	5,395,614

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Barrels

	1938	1937	1936	1935	1934	1933	1932
United States	1,213,254,000	1,279,160,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Soviet Union	206,192,000	201,856,661‡	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	173,506,497	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran	78,320,840	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075	49,516,697
Netherland India: Sumatra	34,538,128	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172	18,570,928
Borneo	12,812,383	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175	15,228,615
Java	6,955,283	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816	3,837,142
Ceram	607,622	537,436	375,823	311,872	273,698	285,335	309,957
Roumania	48,366,000	52,395,725	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	38,505,824	46,455,687‡	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	32,404,000	30,603,660‡	29,913,150	27,410,983	7,639,849	1,094,915	87,840
Colombia	21,581,588	20,297,543‡	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Trinidad	17,736,176	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Argentina	17,076,223	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Peru	15,908,279	17,459,112	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Bahrein	8,297,998	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Burma	7,499,498	7,847,553	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Canada	6,936,479	2,995,025	1,507,931	1,447,204	1,410,895	1,145,333	1,044,412
Brunei	5,387,214	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656	1,200,026
Great Germany: Old Reich	3,850,044	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Ostmark	370,038	221,266	50,092	44,347	27,965	5,765	804
Slovakia and Moravia	130,867	122,790	126,603	136,580	177,797	121,695	126,603
Poland	3,828,438	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Japan	2,511,184	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
British India	2,330,209	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Ecuador	2,257,278	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
Saudi Arabia	495,135	64,968	19,777	Nil	Nil	Nil	Nil
Sarawak	1,624,882	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	1,561,231	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535	1,071,976
Italian Empire: Albania	437,597	380,292	219,693	41,218	17,500	11,437	9,212
Italy	106,083	112,700	129,653	128,615	162,449	213,534	242,563
France	516,240	507,067	534,063	529,664	700,000	786,366	755,146
Hungary	330,829	13,910	100	Nil	Nil	Nil	Nil
Bolivia	106,620	123,123	104,746	163,295	157,875	111,973	41,907
Other Countries	243,000	70,000	37,100	32,300	64,000	54,100	73,300
WORLD TOTAL	1,966,585,707	2,041,168,442	1,797,891,143	1,652,023,331	1,516,760,036	1,438,797,443	1,305,574,242

‡ Preliminary

PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

METRIC TONS

	Aug. 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Jan. 1939	Feb. 1939	Mar. 1939	Apr. 1939	May 1939	June 1939	Preliminary Figures July 1939
United States	14,507,243	13,189,481	13,785,028	13,343,306	13,846,893	13,874,374	12,653,243	14,445,677	14,275,470	14,956,000	14,153,000	14,860,000
Soviet Union[4]	2,414,000	2,401,000	2,387,000	2,366,000	2,339,000	2,332,000	2,400,000	2,469,000	2,480,000	2,536,000	2,590,000	2,500,000
Venezuela	2,455,545	2,404,477	2,564,234	2,417,054	2,474,385	2,438,207	2,201,782	2,323,150	2,521,254	2,624,585	2,439,598	2,525,000
Iran[5]	775,208	750,824	943,864	955,040	876,168	849,376	660,400	927,608	960,120	902,208	918,000[1]	920,000
Netherland India: Sumatra	389,439	391,566	409,288	404,756	426,522	420,001	398,651	434,424	435,476	461,214	447,842	460,000
Borneo	130,294	143,607	150,752	146,310	149,602	149,741	134,354	146,543	142,552	150,238	147,784	150,000
Java[9]	70,387	64,754	70,285	69,149	71,095	71,852	67,576	70,426	65,210	67,888	65,877	71,000
Ceram	7,359	6,759	6,771	6,141	6,144	6,604	7,412	8,634	10,615	11,519	9,897	10,000
Roumania	556,415	534,475	550,000	525,232	541,884	537,111	496,658	538,719	509,710	520,621	499,575	510,000
Mexico[13]	482,171	507,212	491,862	460,025	481,823	367,000[1]	291,000[1]	457,859	461,104	432,000[1]	455,000[1]	477,000
Iraq	379,395	351,508	326,086	324,503	312,734	323,797	262,151	360,817	348,648	356,079	363,854	365,000
Colombia	260,629	250,475	263,669	259,768	266,046	238,406	229,371	253,663	254,802	264,956	258,258	265,000
Trinidad	211,928	213,185	224,385	211,580	234,214	232,537	210,413	229,306	220,717	231,370	221,564	231,000
Argentina[1]	193,800	193,500	194,000	193,500	288,930	218,000	202,000	221,000	220,000	221,000	217,500[1]	221,000
Peru[1]	176,006	167,718	177,893	172,805	175,667	166,281	146,286	159,774	151,973	142,367	138,782	146,000
Bahrein[6]	97,279	97,479	96,660	83,585	85,009	88,264	83,180	89,811	85,920	85,353	88,700	89,700
Burma[7]	88,068	86,101	83,548	81,634	89,985	82,992	58,602	96,423	87,800[1]	90,000[1]	87,800[1]	90,000
Canada[2]	103,298	111,686	86,545	56,280	61,812	67,151	45,000	57,640	71,109	90,793	88,500[1]	92,000
Brunei[3]	58,772	62,688	62,607	63,491	66,939	66,410	59,474	65,749	62,271	65,007	62,000[1]	65,000
Great Germany: Old Reich[14]	45,007	47,256	47,788	45,865	45,111	47,562	47,614	56,654	53,357	58,205	53,412	58,300
Ostmark[15]	4,394	3,994	6,519	5,600[1]	5,111	5,014	6,962	6,454	8,106	9,666	11,289	12,000
Slovakia and Moravia	1,609	1,597	2,008	1,534	1,443	1,545	1,500[1]	1,500[1]	1,400[1]	1,500[1]	1,400[1]	1,600
Poland	43,287	42,366	43,590	42,000[1]	42,688	43,819	40,202	44,968	44,000[1]	45,000[1]	41,000[1]	45,000
Japan[10]	30,955	24,277	31,376	31,913	24,724	32,003	31,094	31,631	31,095	31,469	31,500	31,700
British India[11]	31,174	29,968	29,054	27,322	30,045	35,065	29,445	32,602	30,000[1]	33,000[1]	30,000[1]	33,000
Ecuador	27,412	26,791	27,310	26,314	27,336	27,715	24,325	23,986	23,190	25,544	25,539	27,272
Saudi Arabia	453	5,498	18,570	20,697	18,590	21,100	23,169	29,190	31,821	38,148	41,078	46,450
Sarawak[12]	13,913	16,191	16,150	15,204	15,540	15,214	13,862	15,838	14,197	14,401	14,200[1]	14,400
Egypt[13]	20,583	22,521	29,789	30,285	31,617	44,390	43,045	47,193	46,897	52,838	51,000[1]	52,850
Italian Empire: Albania[16]	746	10,247	Nil	Nil	41,674	14,869	10,179	18,801	36,657	12,266	12,000[1]	13,000
Italy	1,125	1,027	1,071	1,060	986	933	1,005	1,034	968	901	960[1]	950
France	6,000[1]	5,756	5,923	5,713	6,000[1]	5,900[1]	5,500[1]	6,000[1]	5,700[1]	6,000[1]	5,700[1]	6,000
Hungary	4,000[1]	4,947	6,400[1]	5,602	6,167	6,619	6,670	9,049	9,000[1]	9,500[1]	9,000[1]	9,500
Bolivia[1]	1,160	1,000	1,100	1,000	1,130	1,100	900	1,000	1,000	1,000	1,000	1,000
Other Countries[17]	850	7,000	6,700	7,000	6,700	7,000	6,000	7,000	6,700	7,000	6,700	7,100
WORLD TOTAL	23,589,804	22,178,931	23,353,817	22,407,268	23,099,714	22,839,932	20,899,025	23,689,123	23,708,839	24,555,636	23,589,309	24,407,822

[10] Japanese Saghalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[12] Sarawak Oilfields, Ltd., figures.
[13] Anglo-Egyptian Oilfields, Ltd., figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Estimate representing Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuweit and China.
[19] Official Figures—Petroleos Mexicanos.

Comparative Cumulative Daily Averages in Metric Tons

	Jan.-July 1939	Jan.-July 1938
United States	468,008	446,022
Soviet Union	81,637	79,962
Venezuela	80,536	73,253
Iran	28,951	28,574
Netherland India: Sumatra	14,423	12,457
Borneo	4,817	4,713
Java	2,263	2,778
Ceram	305	229
Roumania	17,040	18,300
Mexico	13,872	15,535
Iraq	11,228	11,152
Colombia	8,323	8,389
Trinidad	7,438	6,607
Argentina	7,172	6,373
Peru	4,960	5,801
Bahrein	2,882	3,163
Burma	2,800	2,879
Canada	2,416	2,153
Brunei	2,103	1,852
Great Germany: Old Reich	1,769	1,514
Ostmark	281	179
Slovakia and Moravia	49	52
Poland	1,434	1,373
Japan	1,040	1,005
British India	1,052	883
Ecuador	838	869
Saudi Arabia	1,089	14
Sarawak	482	581
Egypt	1,595	416
Italian Empire: Albania	556	226
Italy	32	37
France	193	200
Hungary	280	77
Bolivia	33	37
Other Countries	224	27
WORLD TOTAL	772,121	737,682

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Metric Tons

	1938	1937	1936	1935	1934	1933	1932
United States	163,228,715	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191	106,289,292
Soviet Union	28,859,000	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100	21,389,300
Venezuela	27,845,286	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193	17,085,334
Iran	10,358,495	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093	6,548,941
Netherland India: Sumatra	4,662,836	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352	2,492,742
Borneo	1,719,783	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849	2,043,707
Java	933,595	960,125	499,097	464,757	510,320	483,331	515,187
Ceram	81,560	72,139	50,446	41,862	36,738	38,300	41,605
Roumania	6,603,000	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000	7,350,321
Mexico	5,716,423	6,896,657‡	6,090,842	5,973,955	5,666,857	5,049,109	4,870,175
Iraq	4,345,000	4,126,185‡	4,079,066	3,724,231	1,048,108	147,943	118,887
Colombia	3,007,935	2,844,251‡	2,614,092	2,452,635	2,416,432	1,833,606	2,287,835
Trinidad	2,472,943	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532	1,425,009
Argentina	2,432,857	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499	1,871,882
Peru	9,099,885	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867	1,311,856
Bahrein	1,130,734	1,058,557	635,555	173,072	39,008	4,293	123
Burma	1,039,960	1,083,391	1,047,593	991,456	1,004,951	982,233	976,589
Canada	876,016	378,430	190,495	182,820	178,233	144,686	131,937
Brunei	707,123	576,545	470,991	471,842	386,478	290,808	171,432
Great Germany: Old Reich	552,074	453,451	444,600	427,400	317,500	238,600	229,700
Ostmark	63,468	33,010	7,473	6,616	4,172	860	120
Slovakia and Moravia	19,282	17,936	18,665	19,946	25,971	17,776	18,493
Poland	504,678	501,301	510,630	614,760	529,200	550,670	556,680
Japan	356,328	341,040	341,976	326,580	266,520	212,667	239,567
British India	322,125	298,450	273,137	281,072	265,341	224,879	240,767
Ecuador	319,877	306,326	275,293	245,434	231,947	229,578	226,423
Saudi Arabia	66,683	8,070	2,447	Nil	Nil	Nil	Nil
Sarawak	200,126	217,085	221,126	253,799	277,513	315,259	332,819
Egypt	223,058	166,298	177,491	176,436	214,671	232,437	265,055
Italian Empire: Albania	65,313	56,760	32,760	6,152	2,500	1,707	1,375
Italy	13,178	14,000	16,106	15,977	20,180	26,526	27,046
France	72,106	71,008	74,788	74,172	98,025	110,120	105,758
Hungary	42,798	13,910	13	Nil	Nil	Nil	Nil
Bolivia	13,262	15,487	13,197	20,540	19,858	14,085	5,284
Other Countries	34,080	10,000	5,300	4,600	9,100	7,700	10,500
WORLD TOTAL	270,979,582	279,495,814	240,539,340	226,410,486	207,970,753	197,024,849	179,181,741

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOPHYSICS

Advancements in the Use of the Gravimeter in Oil Exploration—L. M. and F. W. Mott-Smith, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 10, pp. 85–86, 89–90, 92, 94, 96–97.

Up to a few years ago gravity surveys were obtained almost exclusively by means of the torsion balance. Lately the direct-reading gravity measuring device known as the gravimeter has been developed to a point of such accuracy that the torsion balance has become obsolete. On June 1, 1939, there were approximately 60 gravimeter crews operating in the United States, and a number in many other parts of the world.

The rise of the gravimeter over the torsion balance is due to its freedom from the influence of topographical irregularities and its greater accuracy in following gravity anomalies covering large areas. On the other hand, the torsion balance is probably more suitable for detecting small-scale shallow structures, such as faults of small displacement extending nearly to the surface. Surveys by the gravimeter can cover more territory than can the torsion balance in the same time, thus greatly reducing the expense.

Progress and Trends in Geo-Chemical Methods of Prospecting—J. Brian Eby, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 10, pp. 78–82.

The recent development of geo-chemical methods of exploring for oil and gas has attracted considerable attention as the first attempt to find the oil or gas in place. Geophysical methods, such as seismographic and gravimetric surveys, may indicate the presence of underground structures favorable to oil or gas accumulation, but they furnish no evidence of the actual presence of hydrocarbons. On the other hand, since there is generally a certain upward leakage from the oil or gas bearing formations, a comprehensive soil analysis will give direct evidence of the fact.

While the matter is too novel to admit of positive statements as to the future of this new method of searching for oil, at least it has some successes to its credit, notably in the West Saxet field, where a wax halo that was non-coincident with the ethane halo led to the discovery of an oil horizon above a previously known producing zone in the Frio sand.

First Report of Committee on Geophysics Education—Sherwin F. Kelly, Chairman: MINERAL INDUSTRY EDUCATION DIVISION OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

This is a discussion of a questionnaire sent to all important colleges and universities in the United States and 16 other countries, requesting information on the status of instruction on geophysical education in those institutions; 97 institutions responded more or less fully. The questionnaire was sponsored by the Mineral Industry Education Division of the American Institute of Mining Engineers.

Geophysics is taught as a definite course in three Canadian and 32 American universities. In addition, geophysics is discussed in lectures on geology, physics and engineering in other institutions.

There seems to be a wide latitude in what a student must know before he can enroll as a student of geophysics, but most institutions require a thorough grounding in mathematics, including calculus and in some cases differential equations. Physics is also a required subject; some institutions require only elementary physics, others demand a high degree of training in physics. A more or less advanced training in chemistry is also demanded of the prospective student. The majority of the universities require only elementary geology; advanced geology is required by somewhat more than a third of the institutions.

As regards the geophysics courses themselves, by far the larger proportion of institutions teach the subject as applied or engineering geophysics; that is, as a prospecting tool. A little more than half also teach pure geophysics and two teach only pure geophysics. Most universities have only one instructor in geophysics; St. Louis University has four. There are now 436 undergraduates and 91 graduate students (total 527) pursuing the subject in the United States and Canada. The teaching of general principles is accompanied by practical instruction in the use of field instruments at 20 universities.

This tendency to give a practical trend to the instruction has raised a very animated discussion. The question involved is whether geophysics is to be regarded as an art or as a science. The fact is that some employers (oil companies) who hire geophysicists do not want men trained in particular techniques, which would seem to be a justifiable attitude in view of the fact that only seven institutions in this country have adequate equipment for teaching all the seismic, electrical, gravitational, geothermal and magnetic methods. Perhaps the most important conclusion to be drawn from the questionnaire is the one which states that if universities desire to prepare their graduates for a professional career in geophysics, they are only wasting their own time and the students time if they attempt to concentrate on the minutiae of field techniques. If they are to do their job well they must give their men a broad and fundamental training in the related sciences, so that they will be well equipped to adapt themselves to the particular techniques and procedures which they encounter in their professional careers.

GEOLOGY

Oil Possibilities of Deeper Beds in Southern Illinois—Alfred H. Bell and George V. Cohel, in OIL WEEKLY, Vol. 93 (1939), No. 13, pp. 58–59; 62–63.

The thickness of sedimentary strata in the deeper part of the Illinois Basin is estimated to be more than 10,000 ft. The deepest production of oil obtained so far is from a depth of approximately 3,400 ft. Almost all the oil produced to date in the new fields is from Mississippian strata, the lowest of which, the McClosky sand, is more than 1,000 ft. above the base of the Mississippian. The lowermost two-thirds of the sedimentary column, comprising the lower part of the Mississippian and all the Devonian, Silurian, Ordovician, and Cambrian systems, remains largely untested in the deep part of the basin. Up to date, less than one percent of the state's oil has been produced from strata below the Mississippian.

The authors review the known occurrences of oil and gas in Illinois below the top of the Devonian, and discuss possibilities of production from these deeper strata.

In view of the evidence presented, the Devonian-Silurian limestone appears to have good possibilities of oil production on favorable structures in the Illinois Basin; the Trenton has fair possibilities if it is porous enough; and the St. Peter sandstone, although it has the characteristics of an excellent reservoir rock, has not yet been demonstrated to be oil bearing in the basin.

Geology of Texas Panhandle Oil and Gas Field—Henry Rogatz, in BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 23 (1939), No. 7, pp. 983–1053.

The production of oil and gas in the Panhandle is controlled by the position of the oil-water and oil-gas contacts, which have been displaced from their original horizontal positions by the regional tilting of the entire surrounding area. Because of this tilting, oil occurs structurally higher along the north flank of the ridge on the west than on the east.

The Permian pre-Red-bed section is a thick series of precipitate deposits divided into anhydrite, dolomite, and limestone, together with granite wash. If the beds above sea-level were removed, the new outcrops would show: (1) these formations as ever-widening bands from east to west, along the north flank of the granite core of the buried mountains; (2) the successive series thickening northwest; and (3) the lower dolomite and upper granite wash grading into limestone west and northwest of the town of Borger. The lithologic changes of these formations and the structural features are discussed separately by counties.

Although new shallow oil pools are not to be expected, at least in any great quantities, the possibilities of deep production are practically limitless and exploration is untouched.

The area possessing the best dolomite prospects in Moore County is located in the west and southwest part of the county, along the margins of the Dalhart basin. This is one of the few parts of the Panhandle which has undergone no

development work: It is the largest prospective area outlined, covering an area almost 30 mi. in length and 4 mi. in width, abruptly widening to 10 mi. in the northern part of the county. In the southern part of the Dalhart basin, the most favorable part of the dolomite for production is the top of the "C " and the bottom of the "C. subzones." In the extreme southern part of the Dalhart basin, there was drilled a section of almost 70 ft. of porous dolomite. Along the east rim of the Dalhart basin, the upper "C. subzone" looks more favorable.

An extensive basin lying lengthwise across much of the north end of the county is also prospective.

Classification and Nomenclature of Rock Units, Committee Report, BULLETIN AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Vol. 23 (1939), No. 7, pp. 1069–1098.

A joint committee representing American associations of geologists and the U. S. Geological Department here republishes, without much change, a uniform system in geological nomenclature which will be found useful by those who read geological literature and especially by authors of geological papers.

DRILLING

Possibilities in Horizontal Drilling—Leo Ranney, in PETROLEUM WORLD, Vol. 36 (1939), No. 7, pp. 24–27.

The author describes the methods employed in drilling, shooting and producing a horizontal oilwell that was drilled horizontally for a length of 953 ft. from the face of the outcrop of the oil sand. This horizontal well, located in Havener Run, Morgan County, Ohio, penetrated to about the middle of a 61-acre tract on which were 46 abandoned oilwells. The hole penetrated three producing horizons, revealing untapped pockets of oil that made the enterprise a commercial success.

On the basis of this success, the possibilities of expanding the horizontal drilling process into a more general method of oil production are discussed, with particular reference to California. For instance, there are three oilfields within the city limits of Los Angeles where no surface drilling is permitted. In such a case these fields could be drained of oil by sinking a small shaft to the oil sands, forming a small concrete chamber 20 ft. in diameter, and drilling horizontal wells radially from the chamber. Development costs would not exceed a few hundred dollars per acre. Instead of recovering 15 or 30 percent of the residual oil, as is the case with wells drilled from the surface, the horizontal method should capture from 60 to 85 percent. Other locations offer similar possibilities.

The main difference in favor of horizontal drilling is that it creates, in the oil sand, a drainage channel many hundreds of feet in length, whereas a vertical well penetrates a section only a few feet in length. The method would seem to be particularly adapted to where it is necessary to resort to directional drilling, under the ocean bed or elsewhere. By present methods of drilling, a well may be whipstocked to an angle of 45 deg. from the vertical. By sinking a shaft, it would be an easy matter to enter a well at that point and continue drilling horizontally for several thousand feet out into the sand. As is well known, it is practicable to sink shafts to a depth of nearly two miles.

Weldability of Casing Steel—S. L. Hoyt, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

The author gives metallurgical principles relating to the welding of casing steels, with particular reference to the influence of such factors as the composition of the steel, the hardening characteristics of the heat-affected zone, and the rate of cooling from the critical range.

Critical data as shown are confined mainly to higher-carbon steels.

This paper brings out those principles which relate to the problem of arc welding casing steels. These principles are illustrated by means of two actual cooling curves taken on an arc-welded casing joint in the Carter Oil Company's tests and **S**-curves which most closely approximate the **S**-curves of casing steel that are available at present. This example suggests that variations in the rate of cooling below 1,400 deg. F. may affect, materially, the hardness of the steel in the affected stock. It is found, also, that the time of holding, prior to quenching in the mud, also may be an important and independent factor.

Critical Temperature Ranges of Steel by the Dilatometer Method—L. H. Winkler, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

The practice of field welding of casing is a relatively new undertaking. It is not surprising that conditions have been encountered and certain difficulties experienced which perhaps were not anticipated fully.

As a contribution to a better control of field welding, the author presents dilatometric data for several steels considered for oilwell casing and for many familiar alloy steels. These data are presented graphically, showing the instantaneous length of a four-inch specimen, on heating and cooling, as a function of temperature. Inasmuch as the length of a steel changes as it undergoes transformation, temperatures of transformation are indicated by non-uniformities in the curves, from which some indication can be obtained of the relative magnitude of volume change on cooling. The curves show that for steels of equivalent hardness, when properly heat-treated, the transformations on cooling may take place at greatly different temperatures.

In general, it can be assumed that the lower the temperature of transformation on cooling, the greater will be the tendency toward tenderness on cooling from a welding temperature; and if tubing is to be welded in the field, it may be desirable to consider the dilatometric curves of the steel to be welded if safe welds are to be produced. Supplemental information on grain size and coarsening temperatures is included.

(NOTE: This paper is one of four papers on the fundamental principles involved in the welding of casing. See following abstract.—ED.)

Application of Critical Data in the Field Welding of Casing—L. R. Hodell, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

The papers of L. H. Winkler, W. A. Bruce, and S. L. Hoyt are correlated, and additional experimental evidence is shown to demonstrate the effect of various sub-critical cooling velocities on the hardness of medium-carbon steels. As a result of the information furnished in this and the other three papers just mentioned, it is possible to compute, mathematically, suitable welding techniques. This has been done for a number of varying sets of welding techniques over a wide range of casing sizes. The effect of the change in each of the several variables on the resulting temperature and cooling velocities has been shown by examples. It is concluded that, by proper choice of the chemicals in the casing that is to be welded and of the electrodes which are to be used in the welding, a wide range of oil-well casing can be welded successfully under field conditions by following welding techniques that are compatible with field requirements.

The effects of different rates of cooling, kind of joints and numerous other factors are exhaustively discussed in connection with a wealth of experimental data. One of the outstanding results of this work is that manufacturers may notify field welders of the best rate at which to cool welds made of particular steels.

Preliminary Evaluation of Factors Controlling Rate of Penetration in Rotary Drilling—J. E. Brantley and Edgar H. Clayton, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

Extensive tabulations and charts are presented for more than 500 wells in typical fields of Texas, Oklahoma, Louisiana, California, New Mexico, Wyoming, and Kansas, representing an attempt to ascertain the relative importance of four factors on rate of rotary-tool penetration during the past eight years. The total increase in rate of penetration is given as 123.7 percent, relative importance of three factors being: personnel and equipment, 55.5 percent; rotating speed, 39.6 percent; volume of drilling fluid, 28.6 percent; weight on bit is included in the above figures.

In a final summing up it is concluded:

That, in hard-rock fields, increased rates of penetration depend upon the personnel and improvements in bits and drill pipe. Rotating speeds and fluid volumes apparently have reached their upper limits, as has weight on the bit, in many cases.

That, in rock-bit drilling in relatively-soft material, increase in values of the four factors will result in an increased rate of penetration—although there undoubtedly will be maximum limits for all of these, with the exception of personnel.

In drilling formations of the above types, or softer, with drag bits, the same conditions apparently will obtain: i.e., by increasing the values of the several factors, an increased rate of penetration will result.

In plastic formations, brittle shales, limestones having concoidal fracture, and some other somewhat similar formations, rate of penetration may be increased: by improvement in the personnel and bits; by increased rotating speeds to the practical maximum, and larger fluid volume, together with higher pressure jetting from the fluid nozzles of the bit. The weight on the bit may not be increased profitably.

In plastic, clay, silt and shale formations, rate of penetration increases depend largely upon increased fluid volumes, jetting action of the fluid on bottom, and character of the fluid. The use of the proper type of short drag bits is assumed.

An Economic Study of Slim-Hole Drilling in the Gulf Coast—I. W. Alcorn, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 8, pp. 25–30.

This article gives a breakdown and analysis of costs derived from factual data which indicate the feasibility of exploratory slim-hole drilling for testing deep Gulf Coast structures. Data on the drilling of extra-large (18⅝ in. surface casing), normal holes (10¾ in. surface casing), and slim-holes (7⅝ in. or 8⅝ in. surface casing) are analyzed. The result is to show that drilling of ex-

ploratory small holes has been sound practice, and that its economy is a big factor in its favor.

In general, the chief difference between the operations of drilling a large hole and a small one is that for the same depth a larger number of cubic feet of earth must be removed from the former than from the latter. From this analysis it is seen that, for similar drilling conditions, the rate of drilling or time required to drill to a given depth varies as the square of the diameter of the hole after the surface casing has been set. Hence the slim hole is distinctly a saver of time and, therefore, of money. The author finds reason for believing that slim holes can be drilled to a depth of 9,000 ft. at an average cost of between one-third and one-fourth of the cost of the average conventional exploratory well, assuming average drilling conditions and the use of a Diesel-mechanical rig.

This low cost makes it possible to drill several holes on a prospect to determine the general geological conditions, so that a conventional deep test may be located more rationally.

Survey of Drilling Equipment—Harry F. Simons, in OIL AND GAS JOURNAL, Vol. 38 (1939), No. 7, pp. 34–35; 37.

Replies to thousands of questionnaires sent to drilling contractors and the drilling departments of oil companies elicited the information that there are about 8,022 drilling rigs in the United States, of which 3,860, or 47.2 percent, are rotary outfits, and 4,162, or 52.8 percent, are cable tool rigs. All together, these outfits drilled 32,560 tests in 1937 and 27,149 tests in 1938. During each of these two years, the drilling branch of the petroleum industry spent approximately $90,067,000, much of which went for current supplies and new equipment. Thus, the average annual expenditure is about $11,250 per rig.

The total number of firms engaged in the drilling business is in the neighborhood of 3,340. Several of these firms operating many rigs spent in excess of $1,000,000 for new equipment within a single year; contractors owning only one rig report outlays in excess of $5,000. Drilling departments of several oil companies reported drilling over 800 tests annually; several contractors report drilling over 300 tests. The largest number of rigs under single ownership was reported to be 98 by a major oil company; the largest number reported by a drilling contractor was 63. However, the contractors drill 79.6 percent of the holes and own 77.5 percent of all the rigs. Most of the contract work is in the development of fields, while the company rigs are used mostly for wildcatting. No figures have been obtained as to footage drilled by rotary and cable tool rigs, but it appears certain that the rotary rigs are doing most of the work, especially in the newer areas and for deep drilling.

Over 2,220, or more than half, of the total rotary rigs use steam for the prime movers; other forms of power are used on the following number of rigs: gas or gasoline, 888; Diesel, 523; Diesel-electric, 58; gas or gasoline-electric, 84; straight electric, 61; and combination steam and mechanical, 25. While no effort was made to classify the type of rigs by localities, it was noted that the areas having gas and water supplies, or areas where the drilling was exceptionally deep, used this type of equipment. Some deep areas have used the Diesel-electric type rig. The various types of mechanical rigs seem to find their maximum use in areas where the drilling is shallow or only of medium depth or where there is lack of fuel or water.

The division of cable-tool rigs showed that 953 use steam for motivating power; 1,117 are gas, gasoline or Diesel-driven; 1,232 are spudding machines; 681 are portable standard rigs, and 169 are combination, rotary and cable-tool rigs. Scanning of the localities revealed that the territory east of the Mississippi River seemed to be the most favorable locality, although there are many listed by contractors and companies operating in the Mid-Continent and California.

Some Defects Found in Hardfaced Drilling Tools, and Their Remedies—C. W. Metzger, before OIL WELL EXPOSITION DRILLING AND PRODUCTION COMMITTEE, Houston, April, 1939.

Laboratory investigations on a number of oil well drilling tools are reported, with particular reference to hard-faced bits. The principal defects are listed as follows:

(a) Poor bond between original portion of blade of worn bit and rebuilt section.
(b) Poor bond between base metal of blade and metal used to anchor tungsten carbide inserts.
(c) Poor bond around tungsten carbide inserts.
(d) Poor microstructure of steel in bit blades.
(e) Poor microstructure of steel surrounding tungsten carbide inserts.
(f) Poor microstructure of matrix metal around tungsten carbide grains in final facing layer.
(g) Cracks.

Little trouble is experienced with bit bodies. Rebuilt blades, or even new blades, however, may contain flaws in the form of oxides or gas pockets which weaken the steel and prevent proper refining of the grain structure by heat-treatment. These defects are eliminated by proper control of welding conditions, such floating off the scale as to obtain good penetration, and clean metal. Proper heat-treatment after hard-facing assures maximum toughness through refinement of the grain structure.

The steel used to anchor the tungsten carbide inserts to the bit may contain oxides and gas pockets next to the insert if oxidizing conditions are allowed to prevail. Control of welding procedure through proper flame adjustment and the use of the minimum amount of heat required for the work will remedy these faults. The matrix of steel holding the small tungsten carbide grains in place in the final hard-facing layer may pick up too much tungsten carbide and become too brittle to provide maximum cutting life for this layer, but proper control of welding conditions, such as proper flame adjustment and avoidance of over-heating or holding the material molten for too long a period, will assure the proper condition.

The tungsten carbide inserts and smaller tungsten carbide grains in the final layer may be cracked by a quench following heat-treatment of the steel after the hard-facing is completed, but this can be avoided by selection of a body and blade steel having an analysis which will allow development of the requisite strength and toughness by air cooling instead of quenching and drawing.

Determination of Drilling Data in Rotary Drilling—P. B. Nichols, before AMERICAN ASSOCIATION PETROLEUM GEOLOGISTS, Oklahoma City Meeting, March, 1939.

The present method of recording drilling time is by means of an observer who notes the time and depth at given intervals. Usual procedure is to mark the kelly into equi-spaced segments varying from one to five feet, depending upon the degree of control required. As these marks reach the rotary table, depth and time are recorded. The observer may be the geologist or engineer in charge. Some companies are requiring the contractors to furnish this information, in which case it is taken by one of the floor-men under the supervision of the driller. Accuracy of this method is entirely dependent on the human element.

A recent innovation in the method of obtaining the drilling time is by means of an instrument known as the geolograph. This device automatically records the speed of drilling on a time chart along with such pertinent information as round trips, circulating time, shut-down time, etc.

In operation, a flexible wire line is made fast to the rotary swivel, taken over a sheave about 50 ft. above the derrick floor, down through the instrument and up again into the derrick, where it passes over a second pulley and is kept taut by a weight suspended in a guide of tubing. As this line feeds through the machine in the various drilling operations, the amount and direction of motion is transferred to the time chart. This machine was conceived by P. B. Nichols and developed in co-operation with the Indian Territory Illuminating Oil Company.

As only three of these machines have been manufactured to date, it is yet too early to predict their entire field of utility. Accuracy of the geolograph in indicating stratigraphic changes has been checked by cores and electrical logging, and it is indicated that this instrument will be of value wherever the use of drilling time has proved beneficial.

Gravel Packing—anon., PETROLEUM WORLD, Vol. 36 (1939), No. 4, pp. 34–36.

The practice of packing gravel around that portion of an oil-well hole which is to be completed with perforated pipe, which was originally developed for the completion of water wells, is now becoming common practice in the petroleum industry. The difference is that whereas water wells are usually packed from top to bottom, in oil wells the water horizons must be shut off and the packing confined to the oil stratum.

Gravel-packing is especially called for when the oil sands are so poorly consolidated and of such a fine particle size that the sand works its way into the pump, where it abrades the moving parts; the result is a high maintenance cost, with frequent shut-downs for cleaning jobs. The presence or absence of this condition in old fields is known to the operators; in newly proven areas cores of the formation should be carefully examined to determine the advisability of gravel-packing.

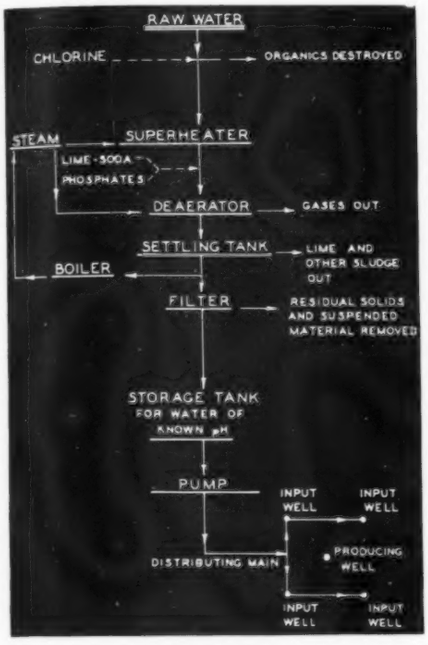
In practice, the oil sand is under-reamed to a diameter of 15 to 20 in. The liner, attached to tubing or drill pipe, is lowered to its place in the bottom of the hole. The gravel, which is usually between one-eighth and one-fourth inch in size, or 10 to 15 times the diameter of the oil-sand grains, is poured in through the annular space between tubing and the water string of pipe until the enlarged portion of the hole is filled. Various special methods and devices are in use for placing the gravel. One successful device is the double gravel-packed liner, which is made by using two casings with gravel packed between the two. By this method the operator knows that the gravel is evenly spaced about the liner, excluding the possibility of bridging. In this case no under-reaming is necessary.

Another use for this type of gravel-packed liner is where a well has been plugged back, and either gun or knife perforated, and the well produces a lot of sand. If the casing is of sufficient size, it is possible to run a small gravel-packed liner inside of the casing, and thus stop the sand from running, and to produce the well.

OPERATION

Chemical Aspects of Water Flooding—Raymond Nauth, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 11, pp. 21–24.

The practice of flooding an oil sand with water to recover residual oil that will not flow to the pump, began somewhat more than 20 years ago. In the course of this development many things had to be learned through hard experience, but with knowledge added to knowledge, the technique of water flooding has now attained considerable precision.



It is now recognized that one of the principal keys to success in water-flooding an oil sand lies in the control of the water employed. In particular, the water must be deprived of all suspended matter and precipitable substances that would clog the pores of the formation and thus put a stop to the input of the water that is expected to drive the oil to the pumping well. Therefore the input water has to be subjected to an accurate chemical control, the lines of this control being based on its composition as disclosed by a chemical analysis.

Aside from suspended matter, which can be removed by filtration, it is necessary to remove bicarbonates from which solid calcium carbonate might be precipitated. For this purpose the water is treated with lime so as to leave a low alkalinity (15 p.p.m.) and a relatively high pH (9.2). Such water will not corrode the iron piping and there will be a slight possibility of underground precipitation. To kill micro-organisms that might produce slimy, pore-stopping matter, the water may be treated with chlorine.

Recently the practice of heating the input water has attracted attention. It has been found that if warm water is used, the life of wells is prolonged because of the lesser deposition of alkaline earth salts in the interstices of the oil-bearing rock; there is less pressure-drop of the water in the sand and oil recovery is increased thereby. Inasmuch as the water contains only a small amount of dissolved minerals, it is possible to superheat this water before sending it down into the oil sands under pressure. Superheated water vaporizes and expands the oil, forcing it toward the producing well.

Typical Dynamometer Cards and Their Application—Eugene Horsford and Enory Kemler, before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

Dynamometer data have applications during three phases of a well's history. The first general application is to the selection of equipment. The second application is to check operating conditions when equipment has been installed, to prevent trouble, or to improve operating conditions. The third is the application of dynamometer data to troublesome wells in an attempt to reduce or eliminate the trouble. Although this latter field of application has received much attention—and justly so—the others should receive more, for it is much cheaper to prevent trouble than to correct it.

The problem is not at first, as might be expected, that of rating the equipment, but it is the more difficult problem of rating the well.

The authors treat the subject comprehensively. They discuss the general applications of dynamometer data, factors affecting dynamometer cards, well measuring instruments, correlation of dynamometer—torque information, well loads, horsepower requirements, use of dynamometer cards for counterbalancing powers, and the like. This publication covers 122 pages in double column and amounts to a full-sized treatise. The bulk of the material consists of actual dynamometer cards and records taken on 444 wells of different depth up to 4,500 ft. deep. Production engineers should find this work valuable for reference.

Vacuum Applied to Oil Production—Harry F. Simons, in OIL AND GAS JOURNAL, vol. 37 (1939) No. 47, p. 59.

Use of vacuum to reduce the pressure on a shallow producing formation has recently been revived in California and Illinois. Reduction of pressure in the well bore results in its having a higher fluid level. With the working barrel and tubing immersed there is a reduction in the pounding of valves and the consequent snapping of the rod strings which ultimately induce failure.

There is considerable disagreement among production men as to the advisability of pulling an extremely heavy vacuum on wells. Some contend that it induces channeling and eventually is injurious to a well; they also object to it on a financial basis, claiming that the oil can be recovered by pumping and the extra investment for quick recovery is not justified. Others claim that the gravity of the oil in the formation is affected, making recovery of a large share of the oil practically impossible.

On the other side it is pointed out that the lessening of the pressure induces fluid movement into the well bore and if the oil is to be recovered, this is essential. Some consider it is related to repressuring, because the lessening of pressure has an effect similar to putting pressure into the sand to cause movement of the oil.

Because of its efficacy over short periods, it is hard for offsetting properties to operate without resorting to vacuum also.

In some cases the production from offsetting wells has been reduced as much as 50 percent, with an abnormal increase of production by the well under vacuum.

A recent installation in California used an International power unit to drive three Chicago pneumatic 12-by-12 in. vacuum pumps that operated three wells; the wells are 4,750 ft. deep and are individually pumped. A compressor is used in conjunction with such a unit.

The vacuum pump is connected to the well head but its discharge is into the compressor. The rich gas thus produced is compressed and is bubbled through the produced oil in a special tank. The mixing of the natural gasoline and crude results in a rise in the gravity in the latter which is enough to put it into a higher-price bracket. By pulling a vacuum, the production of each of the wells is increased 12 bbl. daily in addition to the increase in price obtained from the higher gravity oil.

The unit operates 24 hours a day on 3,500 cu. ft. of natural gas at a cost of six cents per 1,000 cu. ft. Engine load is approximately 38 hp.

NATURAL GAS

Developments and Trends in the Natural Gasoline Industry—J. W. Vaiden and F. E. Fisher, in PETROLEUM ENGINEER, Vol. 10 (1939), No. 10, pp. 44, 46, 48.

One of the circumstances facing the natural gasoline industry is the fact that the petroleum refiner is becoming more independent of the natural product for meeting volatility requirements for his own products. Thus the market for the product of the natural gasoline plant seems to be decreasing rather than increasing. The effect of this situation has not been felt greatly, as yet, and the rapid change in manufacturing methods and requirements of utilization may reverse the situation before the market is too seriously affected. For instance, the recent increase in the anti-knock rating of third-grade motor fuel to 67 octane number indicates a possible increase in use of natural gasoline in this fuel on account of the inherent anti-knock value and good lead susceptibility of the natural gasoline in such a blend.

Also, in proportion as the refiner polymerizes his own butane and butene, he must replace these materials from some outside source.

Nevertheless, it is open to the natural gasoline manufacturer to maintain his position by recognizing obsolescence and taking advantage of progress in technique and plant design, such as recent developments in refrigeration and high-pressure equipment. There is also another way out. If the natural gasoline manufacturer were to adopt the methods of the more progressive refiner, and convert his raw product into a more valuable one by some of the many processes available to the industry today, it seems entirely possible that he would find himself free, to a considerable extent, of low-priced seasonal and uncertain markets.

By dehydrogenation of the paraffin gases, by polymerization, or alkylation, and by hydrogenation, the paraffins can be converted into motor fuels of high anti-knock quality. Thus, by application of a suitable process, natural gasoline may be changed into a premium product rather than a low-priced product offering little profit in its manufacture. The rapid increase in aviation activity, particularly of military aviation, should result in an increased demand for high-octane fuel. The natural gasoline manufacturer has the raw material to supply such needs if he will convert it into the form required.

To carry out these operations, tremendous capital investments are required in equipment and in research bearing on the new products. This results, of course, in high interest and depreciation charges that increase manufacturing cost. Offsetting this cost is the increased price obtained for the new products and the establishment of a more secure market. The natural gasoline manufacturer who finds himself unable to install new equipment, or to modernize his old plants, will soon find himself in a difficult position with little

hope of continuing operation in the face of radical changes in the industrial picture. New processes are being developed constantly.

From an overall viewpoint, it is evident that the natural gasoline manufacturer is somewhere near the cross-roads. Either he must be satisfied with little or no profit in his operations or he must depart from traditional practice and turn his attention toward the newer methods and processes that show possibilities of profit.

Preventing and Removing Gas Hydrate Formations in Natural Gas Pipe Lines—E. G. Hammerschmidt, before AMERICAN GAS ASSOCIATION, Natural Gas Section, Tulsa Meeting, May, 1939.

Since the role of gas hydrates in natural gas systems was discovered (the author was the first to call attention to this important matter), gas distributing companies have found it desirable to install dehumidification plants on their high pressure trunk lines in order to prevent the formation of solidified gas hydrates.

However, there are many cases where, for economic reasons, an investment in dehumidification equipment is not warranted. Such cases include gathering systems, small distribution systems, systems where for climatic reasons gas hydrates are formed at infrequent and generally short intervals, and where hydrate formation is confined to small areas, such as regulator stations, meter runs and overhead lines.

In such cases, relief may be had by the use of antifreeze compounds. This is a subject on which very little has been written, and the author here supplies some valuable information, particularly on the use of methanol as an antifreeze agent in gas lines, on which nothing at all seems to have been published heretofore.

The virtue of an antifreeze substance in this work lies in its ability to lower the freezing point of the freezable substance. Ammonia has been used for this purpose in gas lines, but it is open to several objections, one of which is that it forms a solid substance (ammonium carbonate) with any carbon dioxide that may be in the gas, and thus promotes obstructions. Another objection to ammonia is that it tends to corrode brass and copper fittings in the distributing lines.

An ideal antifreeze compound for gas lines would be a substance that does not form solid compounds and has no corrosive properties. Such a substance is methanol, which is cheap and available in large quantity; it is perfectly soluble in water and is 100 percent volatile under pipeline conditions.

The author illustrates and describes a system for injecting methanol into a pipe line and gives examples of results from practice. For instance, a 15-in. pipe line was delivering 1,300,000 cu. ft. per hour and operating at 325 lb. per sq. in. pressure with 42 deg. F. ground temperature. Hydrate had formed on a 3.2-mi. section of this line, and no fluid could be drained from any of the four drips in this section of the line. On March 2, 17½ gal. of methanol were atomized in this section of the same line during a two-hour period. On March 3, 58½ gal. of methanol were added in the same manner during a six-hour period. At the end of the second period of injection, all of the drips were producing fluid—approximately 300 gal. total—and the efficiency of the pipe line increased from 71 to 84 percent. On another line, hydrate formation was prevented by continuous injection of methanol at the rate of 1.9 gal. per 1,000,000 cu. ft.

In operation, antifreeze vapors are gradually removed from the gas as it passes down streams. Hence it is necessary to determine the amount of antifreeze vapor in the gas at various points in the line. This is done very neatly by a method and apparatus devised by the author, by which a metered portion of the gas is drawn from the line through a glass tube filled with anhydrous magnesium perchlorate (dehydrite) that absorbs only the methanal, which is estimated by dissolving the dehydrite in water and oxidizing the methanol with chromic acid.

REFINING

Exothermic Reactions Supply Entire Heat Requirements for Poly Units—J. P. O'Donnell in OIL AND GAS JOURNAL, Vol. 38 (1939), No. 7, pp. 50–51.

This article contains a description of a small Pennsylvania polymerization plant making 250 bbl. of 86–88 octane material for blending purposes.

This unit differs from catalytic polymerization units previously described in trade literature inasmuch as no supplementary heater or furnace is employed. The necessary increase in temperature for the charging stock is obtained entirely by exchange with polymer gasoline leaving the reactors and by a steam preheater supplied from the top of the reactor cooling jackets. This feature not only reduces installation and operation costs but also permits the use of gases from the polymer stabilizer, which ordinarily are used as fuel for the unit, as fuel elsewhere. The use of a compressor is also obviated in this unit by the utilization of sufficient condenser surface and the maintenance of a high-enough pressure on the reformer and cracking plant stabilizers to condense all gases.

The polymerization unit is charged with approximately 1,500 gal. per hour of liquid condensed from overhead gases of three stabilizers.

Stainless and Heat Resistant Steels in Refineries—Karl E. Luger, before Refining Division, OIL WORLD EXPOSITION, Houston, May, 1939.

The stainless alloys are today accepted material for refinery valve trim. General use is made of the martenistic alloys, although there is a trend toward the use of the austenitic chromium-nickel alloys for cold handling of refinery products. For handling products from catalytic polymerization, some valve trim has been made of 18–8 moly, type 316 alloy, which is perhaps the most resistant of the so-called stainless steels to wet corrosion from reducing acids.

Pumps of various kinds are now liberally fitted with stainless steel. Rods are mostly austenitic 18–8 alloy, shafts of the martenistic straight chromium alloys. Plungers for hot oil pumps are four to six percent chromium molybdenum seamless tubing; sometimes the body is made of these alloys.

Other generally adopted applications of the stainless steels include liners for nozzles of towers, gaskets, orifice plates, thermo-couple wells, baffles, supports and spacers, as well as the tubes of heat exchangers, tray support angles for bubble towers, floats for control valves and furnace dampers. They also have been successfully used for high-temperature air preheaters on stills as well as flue gas recirculation systems.

Stainless steels have been proved economical for the prevention of corrosion in systems used for the removal of hydrogen sulphide and mercaptans from refinery gases and vapors. These steels are beginning to be applied for such uses as guy wires on large torches or flares, sheave wheels for tank float gauges, cables for swing lines, small size pipes for control and instrument lines, discs and seats for vapor valves on tanks.

The stainless steel bubble cap is no stranger. It has been used in fairly large numbers; both in natural gas plants handling sour gases, in the absorbers and stabilizers in the refineries and in the refinery bubble towers. Its principal advantages, in addition, of course, to its outstanding corrosion resistance, is the lack of breakage of the teeth or slots and its extreme lightness. The lack of breakage of the teeth likely will have a particular appeal to those refineries desiring sharp fractionation. Another advantage to be obtained, if desired, is a greater number of teeth or slots per cap, thus allowing more intimate mixture of the vapor and the liquor on the tray, which itself is made now, advantageously, of stainless steel to overcome corrosive conditions.

Stainless steel liners for reaction chambers, flash towers, evaporation, bubble towers, vacuum towers and heat exchanger shells have been used for some time. There is no question but that, properly applied, they fully protect the steel from the high-temperature corrosion and are almost wholly free from trouble. When building a new tower, stainless steel liners can be satisfactorily applied by the fabricating shops by a variety of methods.

Recently there has been a rapid development in the application of the stainless steel liners to existing steel vessels. Towers lined in the field nine or more years ago are still giving entirely satisfactory service. While it is not claimed that a field-lined job can be done either as cheaply or as perfectly as a tower lined in a fabricating shop, it appears to be a well-established fact that field lining can be done both satisfactorily and economically. It is estimated that in the last two years alone, over 100 vessels have been field lined with stainless steel.

Treating Cracked Distillates with Caustic Methanol Solution—P. L. Brandt and J. O. Hougen, in OIL AND GAS JOURNAL, Vol. 37 (1939), No. 46, pp. 98; 100; 103.

Besides the properties that directly influence the performance of a fuel oil in the burner, such as volatility, chemical composition and tendency toward formation of sediment, the oil should have an appearance that makes a favorable impression on the buyer. Whether an off-color has or has not any relation to burner performance. the fact is that the market value of an oil is directly related to its color. Suitable color of an oil at the time it reaches the ultimate consumer can be assured only by refining the oil to a high degree of color stability at the refinery.

Production of a color-stable cracked oil is a more difficult problem than with virgin oils. The usual plant practice is to give the cracked distillate an acid wash, followed by redistillation and blending with color-stable virgin oils.

The present investigation was started to find a reagent that would remove color-forming compounds without attacking the principal hydrocarbons composing the oil. Acid treatment alone, or acid treatment followed by an aqueous caustic wash would not do. It was thought that the color compounds were acidic in nature but insoluble in the aqueous alkali, so a solution of caustic soda in methanol was tried, and a process was worked out as follows: Wash the cracked distillate with one percent by volume of a 25 percent sulphuric acid solution, followed by a wash with six to eight percent of a solution containing 130 gr. of sodium hydroxide per liter in methanol, excluding air as much as possible. After removing the caustic solution by gravity separation the oil

is washed with water to remove traces of methanol and caustic; the washings are combined with the main portion of the reagent and the methanol is recovered by fractional distillation. After removal of the colored sludge, the caustic can be used again.

Although still attended by some annoyances, pilot plant operations indicate the feasibility of the process.

Metal-Spray Protection of Refinery Equipment—D. R. Johnson and Earl K. Dewey, Jr., before AMERICAN PETROLEUM INSTITUTE, New Orleans Meeting, May, 1939.

In view of the reported waning interest of most refiners in the protection of refinery equipment by the metal-spray process, it is of interest to note that Continental Oil Co. has proved to its own satisfaction that metallizing can be used profitably. However, this success has been attained through a series of failures which have emphasized that meticulous attention to details is the only guarantee of success.

The principal applications of metallizing are to cracking-unit reaction chambers, dephlegmator towers, bubble towers, evaporators, lubricating-oil contact kettles, and miscellaneous equipment. Dubbs reaction chambers that were metallized with aluminum have shown no measurable loss from corrosion in 4½ years although rotary cleaning equipment causes an annual average metallizing replacement of four to five percent of the total area originally coated. The dephlegmator towers on Dubbs cracking units have been metallized with aluminum with equal success. A bubble tower of a cracking unit that was processing high-sulphur southeast-New Mexico topped crude and had lost metal at the rate of 0.129 in. a year, was metallized in the corroding zone with 12 coats of 18–8 stainless steel to a thickness of 0.02 in. Satisfactory protection was secured and the same process has been applied in other refineries of the company. Absolute protection of a clay contact kettle has been secured by metallizing with red brass. In a similar manner corrosion and erosion have been prevented. by metallizing the surfaces of storage tanks, drums, ends of pipe-still tubes, exchange-tube sheets, heads and shells, and bull-wheels on Duncan acid-sludge burners. For these purposes use has been made of aluminum, red brass, 18–8 stainless steel and lead. In fact, almost any material that can be drawn into wire form can be sprayed with a metallizing gun. Metallizing pump rods and plungers has furnished some of the best examples of the savings to be made by the use of the metal spray process.

Success in metallizing depends first and foremost on obtaining a firm bond between the wall of the vessel and the metallizing coat. The surface to be treated should be cleaned by sandblasting with sharp flint sand (not ordinary river sand), and oil and coke must be removed from seams and under rivet heads. Even with thoroughly cleaned surfaces, failure is almost sure to follow if the metallizing is done during periods of high humidity, such as often prevail on the eastern seaboard. Dry air should be used for sandblasting and metallizing should follow without delay.

Current aluminum applications are being made at a unit cost of from 70 to 75 cents per sq. ft. Obviously, the cost of metallizing small areas is higher. For example, repair work will cost from $1.10 to $1.15 per sq. ft.

The cost for spraying the other metals will vary—depending on thickness of coating, cost of sprayed metal, and extent of surface covered. For example, they have applied lead coatings for as low as 70 cents per sq. ft.—although the cost of 18–8 stainless-steel metallizing has been as high as $2.25 per sq. ft.

CHEMISTRY

Destructive Hydrogenation of a Buscani Residue—C. Candea and L. Sauciul, in PETROLEUM, Vol. 35 (1939), No. 2, pp. 361–363.

A cracking residue from Buscani crude, boiling over 330 deg. C., was mixed with a catalyst and heated with hydrogen in a pressure bomb. The most favorable temperature was 440 deg. C. molybdenum trisulfide and molybdenum trioxide were used as the catalysts. The former has the better cracking action and gives higher gasoline yields; molybedenum trioxide, on the other hand, has a pronounced hydrogenating action, and although its use results in lower yields, the gasoline produced has a higher degree of saturation.

Testing the Ageing Tendencies of Lubricating Oils in the Laboratory—F. Jostes and Andreas Hann, in OEL UND KOHLE, Vol. 15 (1939), No. 26, pp. 515–518; No. 27, pp. 533–537.

Stability in use, or resistance to ageing, is a property which is insistently required of a motor oil, because a tendency to increase in viscosity and to form sediment has a great influence on the operation of the motor and the economics of lubrication. This explains why both users and manufacturers of lubricating oils have sought for a laboratory method by which the ageing characteristics of these oils could be predicted. The number of different methods that have been proposed for the purpose is evidence that existing tests have fallen short of the ideal.

In taking up anew the search for a real ageing test, the authors first clarify their ideas of what will be necessary for obtaining comparable results, and they state a proposition which appears to have been overlooked heretofore: The ageing tendency of an oil can be defined only by the time required, under uniform outer conditions, to reach a given age characteristic. From that standpoint the actual outer conditions and the particular character that is used as a measure of ageing tendency play a subordinate role.

Among all existing methods, only the Indiana test makes an approach to recognizing this requirement. This test defines the ageing tendency of an oil by the time required to produce in 10 g. of oil 100 mg. of asphaltic substance precipitable by standard gasoline. In oils whose ageing as defined by this test exceeds 50 hours, the increase of viscosity from that point on is employed as a measure of ageing.

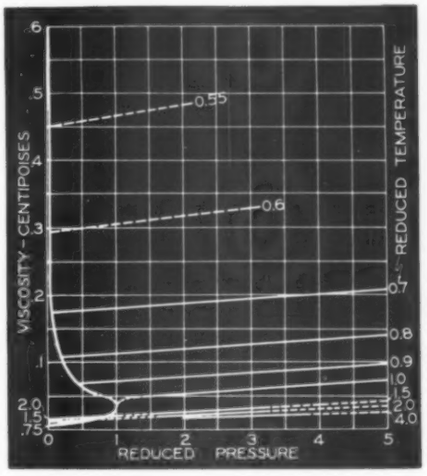
As stated, the authors take the position that a real ageing test with time as an essential measure should be independent of the outer conditions, and they investigated the question of whether the outer conditions are of subordinate importance in the Indiana test. Without giving the details in this abstract, they find that such is the case, and that the way is open to making the Indiana test more convenient to execute. In this test in its current form, 10 liters of air per hour are led through 300 c.c. of oil which is kept at 172 deg. C.; at regular intervals 10 g. of oil are removed by a pipet and the insoluble asphalt is determined. If the amount does not reach 100 mg. in 50 hours the viscosity is measured at 50, 100, 150 and 200 hours.

The test is now modified as follows: 20 c.c. of oil is placed in Jena glass tubes 30.5 cm. long and 1.8 cm. inside diameter; air is led through at the rate of 650 c.c. per hour. At regular intervals a little more than one gram of the oil is removed, extracted twice with gasoline, the asphalt removed by centrifugaling and weighed. The results are plotted, and from the curve obtained, the time for obtaining 10 mg. of asphalt per gram of oil at 172 deg. C. may be predicted. To shorten the process, the temperature may be fixed at 200 deg. C. and the definitive amount of asphalt established as 15 mg. per gram of oil.

PHYSICS

Viscosity of Gases Handled in Distillate Plants—W. L. Nelson, in OIL AND GAS JOURNAL, Vol. 38 (1939), No. 9, p. 50.

A curious fact, which most plant men have difficulty in appreciating, is the great density of the gases that are encountered in plants that have to handle the products of the so-called distillate oil-wells. In many respects these gases behave as much like liquids as like gases and hence it is necessary to revise our preconceived ideas of the properties of a gas and, perhaps, even refrain from referring to the fluids that are handled in distillate plants as gases and simply refer to them as fluids. One customarily thinks of gases as

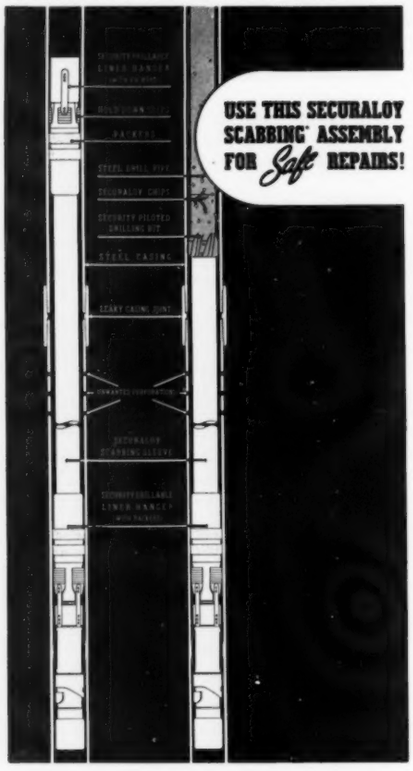


Approximate viscosity of hydrocarbon gases and vapors

materials which weigh about 0.08 lb. to the cubic foot, or at usual high pressures, about 2 or 3 lb. per cubic foot. Compare such densities with weights of 9 to 13 lb. per cu. ft, for the fluids handled in a distillate plant operating at a pressure of 2,250 lb. The friction losses involved in handling such fluids are also high, being about 20 percent greater than those encountered in normal gas systems. Likewise, the usual idea of the transfer rate of gases in heat exchangers is in the range of 2 to 15 B.T.U. per square foot of heating surface, per degree of temperature difference, whereas the transfer rate in distillate plant exchangers is often 50 or may even exceed 100. All of these comparisons point to the fact that the fluids encountered in distillate plants cannot be considered as gases in the ordinary sense, and that special attention must be given to their physical properties.

It is particularly desirable to have an idea of the viscosity relations. The data for estimating the viscosities of these products are none too plentiful, but enough has been gathered together for construction of the accompanying chart.

NO. 9 OF A SERIES SHOWING HOW SECURALOY INCREASES DEVELOPMENT EFFICIENCY



OCCASIONALLY operators are confronted with the problem of repairing a damaged section of casing to exclude water . . or it is found necessary to seal off certain undesired perforated liner or screen sections . . or one or more leaky casing joints must be repaired. For this type of work, the SECURALOY "Scabbing" Assembly (placing pipe sleeve within an existing liner or casing) is unequalled. It is easy and positive to set, requiring only one trip into the well . . it forms a tight permanent seal top and bottom . . it may be cemented in place, if desired . . and, being made of SECURALOY, *it can be completely drilled up and circulated out of the well whenever necessary.*

SEALS TOP AND BOTTOM

• The Security Drillable "Scabbing" Assembly is essentially a section of SECURALOY Pipe (the length depending upon the distance to be sheathed) with a *drillable* packer at its upper and lower ends.

The lower packer is similar to a Security Drillable Slip Type Hanger with packing elements, except it is threaded at the top instead of the bottom to accommodate the pipe sleeve section. Although the "Scabbing" sleeve ordinarily is blank pipe, it may be pre-perforated to any desired mesh should it be desirable to have a secondary screen placed inside of damaged slotted pipe or screen.

A Security Packing Type Hanger with reversed slips is attached to the top of the "Scabbing" Assembly and, when located in its proper position, the packing is expanded with a Security Delayed Action Packer.

ONLY ONE TRIP REQUIRED

• Only one trip into the hole is required to lock the sleeve firmly in place and expand both the top and bottom packers. The unit is lowered into the well on a Security Left Hand Releasing Tool (equipped with Delayed Action Device) and when the desired point is reached, the slips on the bottom packer are set and the packing seal expanded in the conventional manner. Then the run-in string is backed off and lifted a short distance, thus placing the Delayed Action Setting Device in operating position so that, as the weight is again lowered, the upper packing seal is packed off. The operation is as simple as that—and note that each packer is expanded separately under individual control!

If it should be desired to cement the sleeve in place, this can be accomplished readily by using suitable cementing equipment. *The cementing operation does not necessitate an additional trip into the well!*

Full details on the uses of this "Scabbing" Assembly will be supplied by our Engineering Department upon request.

The Security Equipment used in this "Scabbing" operation is described in the 1939 Drilling Equipment Directory and the 1939 Composite Catalog. Descriptive folders are also available.

* *"SCABBING" is the operation of sealing over a defective or unwanted perforated section of casing.*

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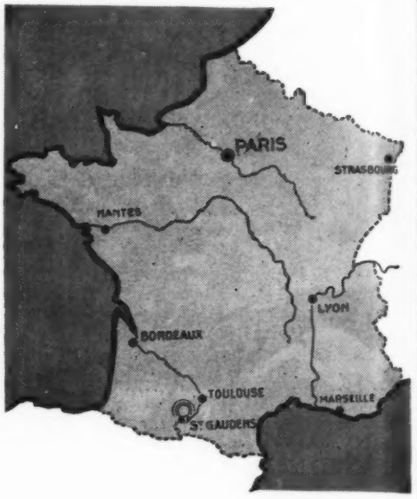
FRONT COVER shows the Wilmington oilfield, in California—photo from Snider-Triangle.

REPORTS from Spain are that the oil industry, like others in that country, is steadily working back to normal conditions. Campsa and Cepsa are both reinstalled in their Madrid offices and are functioning as before the war. Up to the present time no legislation modifying the petroleum regime has been brought forward by the national government but the Department of Industry and Commerce is not permitting the importation of lubricating oil by agents and distributors of internationally known brands and it is believed that this branch of the trade will be reserved to Campsa in future.

ELABORATE steps have been taken by the British Government to ensure conservation of petroleum products in the event of war. Between 7,000,000 and 8,000,000 gasoline ration books and 35,000,000 coupons have been printed and distributed throughout Britain. According to these plans, motorists will be prohibited from hoarding gasoline so that air raid risk will be minimized. At the same time, should war break out, gasoline would be apportioned in amounts relative to the horsepower of each car and the number of pleasure trips, as contrasted to the commercial transportation, would be severely restricted. Efforts to strengthen Britain's position with regard to fuel in case of war have developed along the line of experimentation with fuel substitutes. While no statements have been forthcoming regarding either the actual construction of plants for the manufacture of substitute fuels or the processes by which such manufacture is contemplated, government officials have admitted that vehicles propelled by gas (gasogenes) were included in recent experiments.

OFFICIAL announcement now has been made by the Saudi Arabian Government, of the grant of the augmented concession to California Arabian Standard Oil Company last May. The new grant, which covers 89,000 sq. mi., includes the Saudi Arabian Government's rights in the neutral territories by Iraq and Kuwait and extends along the northern and southern boundaries of Saudi Arabia. The area extends westward from the earlier concession but, fails to include, despite current reports, oil-prospecting rights in the fairly large area of central Nejd. As the original concession covered some 165,000 sq. mi., the new grant brings the California Arabian rights to a total of 254,000 sq. mi. In return for the new concession, the California Arabian Standard agreed to make an immediate payment of £140,000 ($700,000) and to pay an annual rental of £20,000 ($100,000) until it should either declare the existence of oil in commercial quantities or surrender the area. Following any such declaration, the royalty payment would be 4 s. ($1.00) per ton as under the old agreement.

THE RECENT tapping of what appears to be an important gas reservoir at Pinat near St. Marcet is a vindication for the veteran French geologist, Leon Bertrand, who for years vainly has been calling attention to well defined anticlinal structures in the foot hills on the north flank of the Pyrenees.



Heretofore the search for oil in France has been confined mostly to regions where oil or gas seepages were noticeable; the Pinat well is the first attack on a structure remote from surface shows. Between 4,940 and 4,972 ft. the bit penetrated a sand which gauged about 6,500,000 cu. ft. of a wet gas per day. The well is apparently on the top of the anticline—a fact which encourages government officials to believe that further drilling to lower depths will reveal a good pool of liquid hydrocarbons.

This discovery, by raising hopes for petroleum in the French sub-soil, has focused attention on other known structures, where drilling is being carried on at the same time as other wells are being put down at the site of the St. Marcet discovery.

M. O. JOHNSTON Oil Tools Inc. recently acquired the Sub-Surface Pressure Survey Service previously conducted by Commander W. H. Osgood, former retired naval officer who has been recalled to active duty. It is planned to expand this service to supply the ever increasing requirements of this type of work and carefully maintain the high standard of accuracy and confidence always associated with this service under Commander Osgood. The Sub-Surface Pressure Survey Service offers the operator a means of continuing a pressure record after well completion by periodic runs throughout its economic life.

IN THE JULY issue of WORLD PETROLEUM in the article entitled "French Imports of Refined Products", an item of 508,842 tons was described incorrectly as Aviation Gasoline. It should have been termed Tourisme Gasoline.

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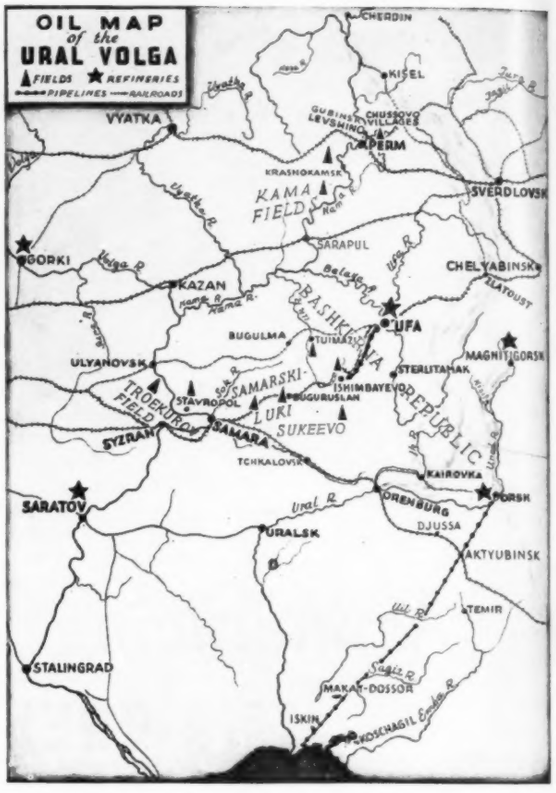

THE URAL-VOLGA region, situated in the eastern part of Soviet Russia, north of the Caspian Sea and northwest of the Ural River, has long been considered by geologists as an important oil base. Even before scientific study of the territory commenced, the presence of springs with oil seeps and of denuded bituminous layers indicated that petroleum was present in this region.

Starting in 1768 with Lepekhin, noted authority on geology, and continuing with many other Russian geologists, the Ural-Volga was surveyed repeatedly for oil. In 1860, Romanovsky contended that there was a link between the surface outcrops and immense oil deposits situated in the layers of the Carboniferous and Lower Carboniferous ages. Subsequent to a confirmation of Romanovsky's contention by A. Pavloff, another outstanding geologist, an English group —Kazan Oil Fields—was formed in 1913 to drill at Samarski Luki and Sukeevo. Nobel's acquired large tracts of land along the Volga a year later and it is probable that this would have meant the start of a large development between the Emba region and the western Ural slopes had not the World War hindered such growth.

Interest in this area was revived some time after nationalization of the oil industry when, in 1929, the drilling of an Artesian well for the Chussovo Villages accidentally tapped oil. Prospecting operations, renewed at this time, were carried further south from Chussovo Villages to the Bashkir republic where oil was discovered at Ishimbayevo. The field was opened in 1932 when two wells came in simultaneously when prospecting. Wildcatting at Samarski Luki began in 1931 and significant results were achieved in the year following. Oil was discovered at Syzran in 1933 on properties which were pointed out as oil bearing by Professor Pavloff some 70 years earlier.

The late Professor Gubkin asserted that during the geological period when terrestrial transgressions in the Ural-Volga territory had taken place, the layers were formed from laminations of sand, clay or other crushed material. Coal and oil were formed during similar or identical transgressions but Gubkin believed that the coal was formed where lakes and swamps existed formerly, while the oil was formed where there had been ravines abounding in vegetable matter. The formations arising from these transgressions extend to Tuimazi, Syzran, Buguruslan, Kama and many other properties of the Ural-Volga territory.

According to Soviet geologists, Samarski Luki occupies a geological position intermediate between the Moscow coal basin and the entire Ural area, and for this reason is repre-

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sentative of the structure of the latter territory. Study at Samarski Luki reveals that the layers there consist of, first, the lower Carboniferous and layers transient between the Carboniferous and Devonian formations; second, Turney formations; third, Visey formations; and fourth, microfauna between the Lower and Middle Carboniferous layers.

The transient layers between the Carboniferous and Devonian formations, at a depth of 3,300 ft., are composed of sandy chalks with laminations of greenish marley. The Turney layers, just above these layers, divide into two horizons, the first of which is represented by light chalk and the second by a sand-clay mass high in pyrite clay content. The first horizon of the Visey layers consists, for the most part, of dolomites and dark bituminous marley. The second horizon is composed of dense brown gypsum clay and dolomites. Over these layers, in the Middle and Upper Carboniferous strata, clay and chalk predominate.

While most of the oil thus far discovered in the Ural-Volga territory has been in these three subdivisions of the Carboniferous age—lower, middle and upper formations—some oil was struck at Buguruslan during 1935 in the Permian system at about 950 ft. These wells at Buguruslan yielded from six to ten tons daily.

All the early wells were drilled to depths between 3,000 and 3,500 ft., but the rate of production at this level was disappointing, the yield coming between ½ to 1½ tons per well daily. When wells were drilled to greater depths, considerably increased yields were obtained, with the average well producing between 100 and 150 tons of crude per day.

This wide difference in production between the two levels suggests the existence of important geological differences in the strata. The structures are divided into Horizon "A" situated between the Lower and Middle Carboniferous layers and layer "B" situated from 1,650 to 2,600 ft. deeper between the Visey and Turney folds of the Lower Carboniferous layers.

Tectonic lines appear to center at Buguruslan, with the first traveling northeast through Tuimazi and cutting the Uk River at about the same point as it is bridged by the Ulyanovsk-Ufa Railroad, the second moving west to the upper part of the Sok River, and the third going further north towards Vyatka and then back across the Volga River where it divides, with one of its branches going west and the other, east.

The Ural-Volga area is spread over a tectonic line showing few variations, and the existence of only two layers is in sharp contrast to the stratigraphy of the Baku fields, where between 18 and 20 layers are found. Oil is found at the shallowest depths in the vicinity of Buguruslan, where wells come in at the upper level at depths between 1,150 and 1,300 ft. The existence of this upper level at so shallow a depth indicates that the lower Carboniferous also may be shallower at Buguruslan. Thus far, the only drilling that has been done to the lower level has been at Ishimbayevo, while drilling to the upper

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layers has been common at the Stavropol, Kama, Syzran, Troekurov, Gubinsk and Levshino.

The lack of more than two producing horizons is more than compensated for by the tremendous area of oil-bearing territory present in this region. At Tuimazi alone, allowing a spacing of ten acres to a well, more than 2,000 wells could be drilled, while if similar spacing were applied to all the Ural-Volga fields, it would be possible to drill as many as 10,000 wells.

While the magnitude of the petroliferous area indicates that many wells may be drilled in this area, as yet only 200 wells have been sunk at Ishimbayevo, while 50 wells have come in at Kama, 30 at Syzran, 20 at Buguruslan and no more than 12 to 18 wells at any of the other fields of the Ural-Volga group.

Production from the Ural-Volga region can be expected to reach 2,000,000 tons during 1939, with the greater portion—between 1,400,000 and 1,500,000 tons——coming from Ishimbayevo. The field having the best prospects for rapid expansion is the Kama field, where the number of wells is to be doubled, during 1939, indicating that production from this area should turn upward sharply. In 1938 the Kama field produced 30,000 tons of crude—a crude that contains sulphur but that is high in its content of light products, yielding 25 percent gasoline.

Drilling equipment and methods differ but little from those employed in the major fields of the Caucasus.

The Ishimbayevo oilfields are connected to a refinery at Ufa by a 10 in. pipeline, 91 mi. in length and capable of transporting 1,000,000 tons a year. Other oil transportation from the Ural-Volga district is by rail, with the connections for the current production being more than adequate.

By the end of the Third Piatiletka in 1942, it is planned to boost the Ural-Volga production to between 7,000,000 and 8,000,000 tons yearly. From 10 to 12 refineries are to be built at the various fields during this period to handle the increased output contemplated, and these producing and refining centers are to be connected by pipelines to the industrial centers of Siberia and those regions of Siberia near the Soviet Far East.

Plans for 1939 production call for about 2,000,000 tons from the Ural-Volga, aside from the expected Emba production. This is a large increase over the 1938 production from the Ural-Volga of 1,400,000 tons. Not only was the Ural-Volga production considerably higher in 1938 than that of its neighboring territories—450,000 tons for Emba, 1,100,000 tons for Bashkiria, and no more than 300,000 tons for any of the others—but also it is increasing at a far more rapid rate. While Emba's production has risen but slightly in the past few years, that of the Ural-Volga rose from 600 tons in 1929 to 10,600 tons in 1932, 74,800 in 1934, 413,800 tons in 1935, to 976,000 tons in 1937 and to the 1,400,000 figure in 1938. Added to this, current operations reports for the first six months of 1939 indicate that the Soviet's ambitious goal for this field is being fulfilled.

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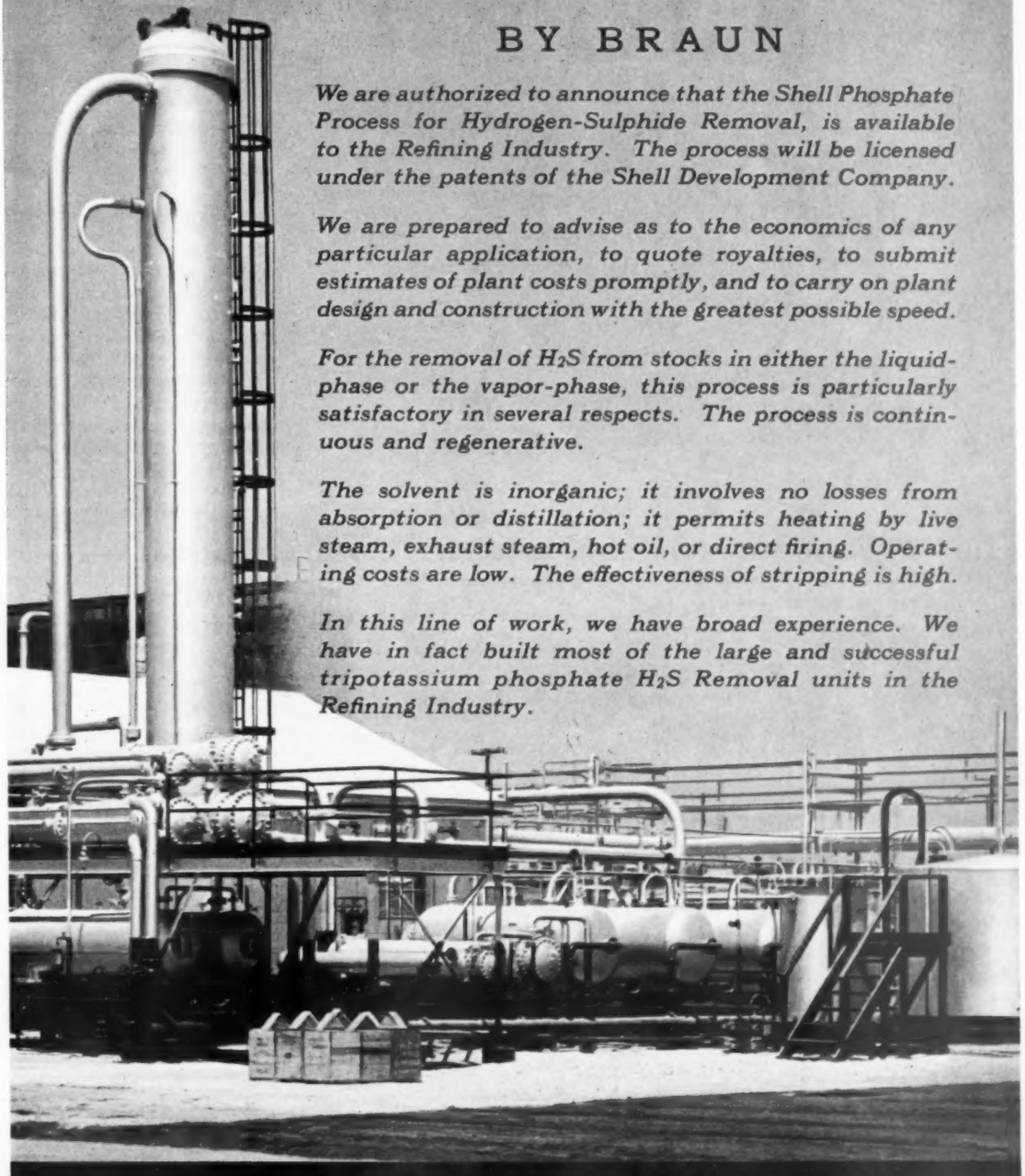

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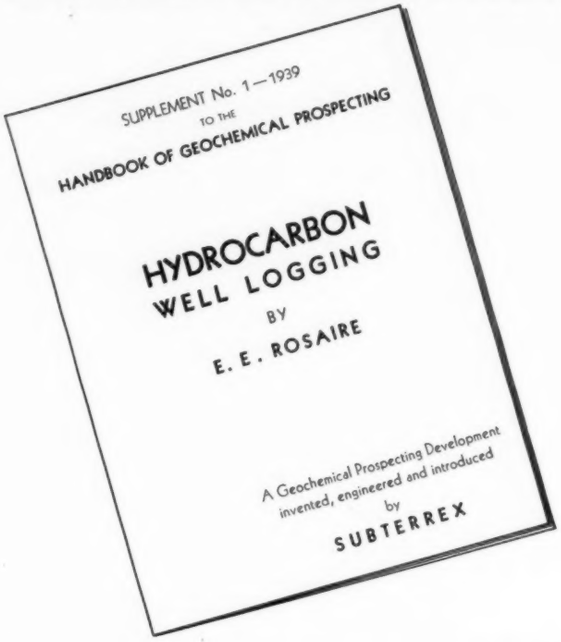

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Soviet Ukraine

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In 1933, while drilling at 200 ft., natural gas and salt sandwiched between other formations were discovered at Romni. The presence of salt and brine have caused the Soviet geologists to believe that the structures are those of the Permian age. Core tests showed that between 25 and 560 ft., deep green clay with sand was present; between 560 and 625 ft., compact pyrite with sand; between 625 and 1,804 ft., chalk; between 1,804 and 2,007 ft., pyrite clay and lumps of stone; between 2,007 and 2,190 ft., various clays, white sand and gravel; and sand and salt water below this level.

At places in the Don Basin coal region, such as Lugansk, gases that were present were studied. All this study, while failing to reveal oil in commercial quantities, has maintained the belief that oil will be discovered in this area. J. WEGRIN

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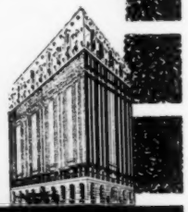

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